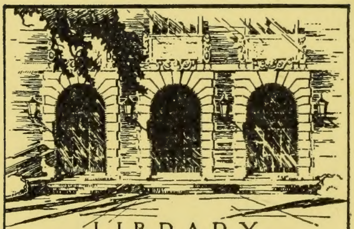

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Vol. LII OCTOBER, 1910 No. 4

# ANNALS OF SURGERY

## A Monthly Review of Surgical Science and Practice.

**Edited by LEWIS STEPHEN PILCHER, M.D., LL.D., of New York.**

WITH THE COLLABORATION OF

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ANNALS OF SUR[illegible]RY

VOL. LII OCTOBER, 1910 No. 4

## ORIGINAL MEMOIRS.

# TRANSFUSION BY CARREL'S END-TO-END SUTURE METHOD.

WITH REPORT OF CASES.

BY EUGENE H. POOL, M.D.,
AND
R. D. McCLURE, M.D.,
OF NEW YORK.

THE interest in direct transfusion of blood, aroused in the last few years chiefly by the work of Crile, has centred upon efforts to develop an easy and reliable method of forming the anastomosis. All of the numerous methods which have been advocated are really modifications of one of four procedures, namely: end-to-end suture—Carrel; approximation by apparatus—Crile, Elsberg, Soresi, Levin; vessel interlocking by end or lateral implantation—Hartwell; interposition of a foreign body link—Brewer, Frank.

A detailed discussion of these cannot be given here. Time and experience alone can prove which of the methods is the best. Careful reports of efforts at transfusion should be encouraged, so that sufficient wealth of material may accumulate to lead to definite conclusions.

Series of cases in which the various methods have been

26 1948

employed are most instructive, and it is for this reason that we report twelve transfusions which have been made by the Carrel method of end-to-end suture. The therapeutic indications for transfusion likewise present a fertile field for physiological and surgical research, but we do not feel that our experience has been sufficient to warrant elaborate discussion of this phase of the subject.

The technic as initiated by Carrel is as follows: A donor free from advanced arteriosclerosis and giving no history or signs of syphilis is chosen. Hæmolytic and agglutination tests with the two bloods may be carried out if circumstances permit, but the necessity for and value of these tests are undecided.

A radial artery of the donor and a vein of the arm or leg of the recipient are the vessels of selection. One-half per cent. novocaine is used as the local anæsthetic. Adrenalin must not be combined with the novocaine on account of its constricting action on the vessels. In addition to the usual dissecting instruments, two small thumb forceps, several serrefine clamps of varying strength covered with rubber tubing to avoid injury to the vessel wall, fine Chinese silk, No. 16 Kirby needles, a rubber bulb with a small irrigating tip, and vaseline are required for the operation. The radial artery above the wrist is exposed. This dissection is facilitated by having the wrist extended over a sand bag. The deep fascia is exposed and opened upon a grooved director passed beneath it through a small hole. In freeing the artery a sharp knife is used so as to make a clean dissection, and contact of instruments with the vessel is avoided as it may stimulate contraction of the muscular coats. About three inches of the artery and from three to four inches of the vein are exposed and freed. After absolute hæmostasis is established, the branches of the vessels being ligated at some distance from the main trunks, the limbs of the donor and recipient are brought into juxtaposition and loosely bound together to prevent tension on the anastomosis by movements of the patients. Serrefine clamps of suitable strength are applied centrally on each vessel, and ligatures distally. The vessels are cut across with sharp straight scissors about one-eighth of an inch from the ligatures. The blood is quickly stripped from them, after which they are washed clean with physiological salt solution by means of a fine glass tip with smooth end attached to a rubber bulb syringe. The entire wound, especially the cut ends of the vessels, is covered with vaseline. This prevents clotting on the injured intima if any blood should escape, and is an important step in the technic. The adventitial coat of each vessel is grasped between the thumb and forefinger, drawn over the vessel end, and severed with sharp scissors; it then retracts so that it cannot be included in the suture. To facilitate the handling of the white suture material, black silk towels cover the entire field with the exception of the ends of the vessels.

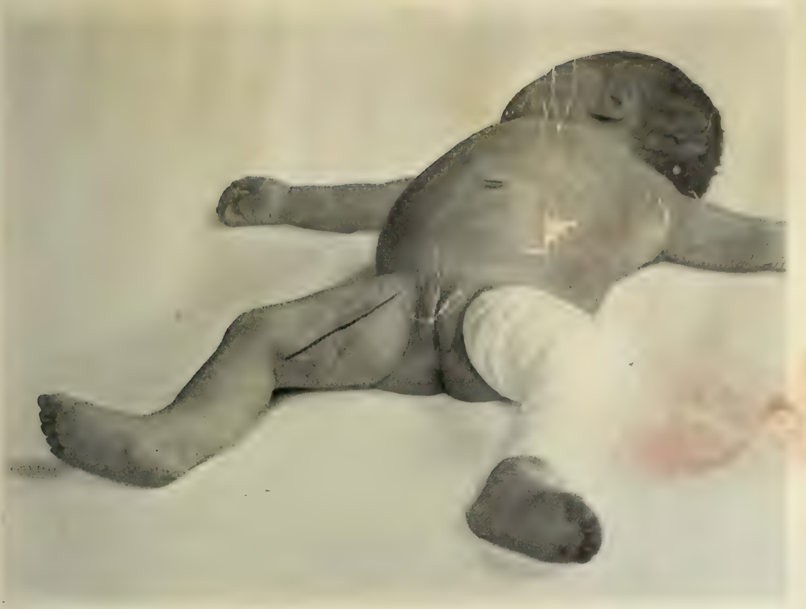
The ends are approximated and held together by three retention sutures of the finest Chinese silk, which divide the circumference into three equal parts. Each of these parts is successively put upon the stretch by traction on the retention sutures, and a continuous suture is thus easily run around the whole circumference, care being exercised that each stitch avoids the adventitia but includes the media and intima at a uniform distance from the cut edge. The intimæ of the two vessels are thus slightly everted and brought into contiguity. Three or four stitches are sufficient along each side of the triangle. The needle and thread of one of the retention sutures, preferably that tied last, is used for the entire circuit, a single knot being made with each retention suture as it is reached. After the completion of the suture, the anastomosis is gently surrounded by a small piece of hot moist gauze, the serrefines are removed, and the blood is allowed to flow from the donor into the patient. If there be any leakage it is usually quickly checked by the gauze. If a point bleeds persistently, as in two of our cases, a stitch may be added easily and effectively while compressing the artery between thumb and finger, when slight release of pressure demonstrates the site of the leak.

If the vessels have been roughly handled or have been seized by the dissecting forceps, small constriction nodes appear, which markedly retard the flow. These may disappear after the application of very warm salt solution.

An argument in favor of the Carrel suture is that the anastomosis is not guarded by a rigid mechanical device, and can, therefore, be rolled and massaged with the rest of the exposed parts of the two vessels, if the flow appears too slow. Such stripping between the well-vaselined fingers has in our experience tended to keep the vessels dilated, thus permitting a full stream of blood. Another favorable feature of the Carrel method is that the calibre of the vessels is not diminished, and extreme dilatation at the site of the anastomosis is possible because the line of suture is on the stretch during the anastomosis. The strain is divided among many stitches, which, though frail in themselves, allow any reasonable amount of rough handling when combined. The absence of apparatus also prevents obscuring of the site of anastomosis so that any twisting of the vessels is at once apparent and can be easily corrected.

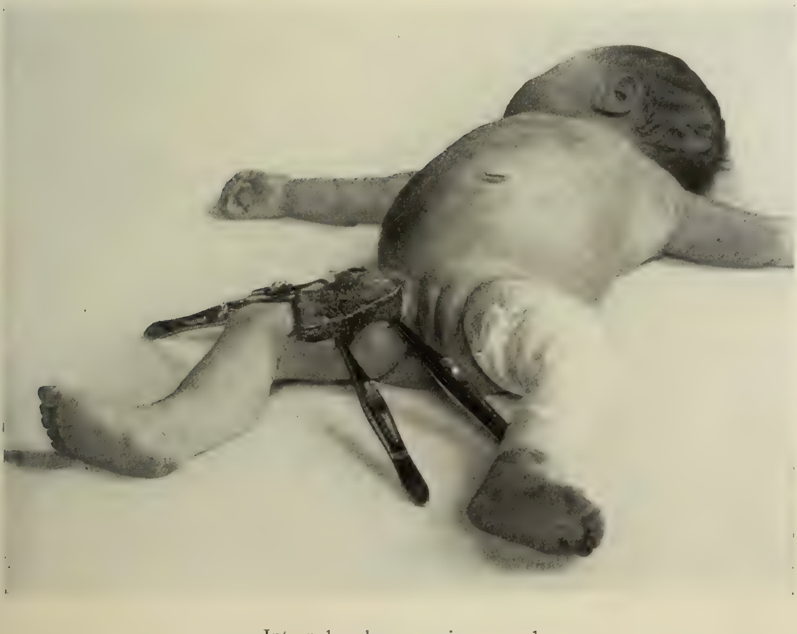
Although the median cephalic or median basilic veins may be used in adults, in infants and in children the saphenous or femoral veins are more favorable for transfusion. The position of the saphenous vein is definite, its length is sufficient, and there is no danger of injury to important structures or to the circulation of the limb; its calibre alone is questionable. In infants and young children it is too small. It seems wise, however, to examine it before exposing the femoral vein. The depth of the vein in the subcutaneous fat may cause some delay in locating it in the small subject, unless its anatomical position is definitely borne in mind. It can be readily exposed by abducting the thigh to about 65° and rotating it outward and making the incision in a line passing from slightly external to the spine of the pubes to the inner aspect of the popliteal space at the flexure of the knee. This lower limit corresponds to the posterior margin of the inner condyle of the femur. On cutting through the subcutaneous fat the

FIG. 1.



Incision for exposure of internal saphenous vein in thigh.

FIG. 2



Internal saphenous vein exposed.

vein is found close to the deep fascia (Figs. 1 and 2). In several of our adult patients we have used the saphenous vein near the ankle.

In one case where the median basilic vein was used, it was noticed that blood flowed far more freely from the cut end of the vein after the transfusion was finished (viz., three drachms in fifteen seconds), than could have been possible during the operation. There must, therefore, have been considerable resistance in the vein. This resistance can be diminished by elevating the limb of the donor, and in Transfusion VIII this was attempted. The saphenous vein was considerably larger than the artery, and subsequently the distal inch of the latter dilated to the size of the vein. The flow was so free that pulsation could always be felt and for the most part seen in the whole of the exposed vein. The donor lay on a high operating table; after the vessels had been exposed the recipient was placed on a stretcher at right angles to the donor with her feet on the table against his chest, her head being considerably lower so that she was inclined about 45°. With the donor's arm abducted 90° it brought the vessels together in a favorable position for the operation. The inclined position seemed to facilitate the flow by diminishing resistance in the veins. It must be borne in mind that in this position overdistention of the heart is more likely to occur.

The physiological effect of the transfusion should be noted at frequent intervals by testing the hæmoglobin, pulse, and blood-pressure. The area of cardiac dulness should be frequently mapped out, and the stethoscope freely used to detect any inability of the heart to cope with the increase in the volume of blood. Finally, considerable information as to the mechanical success of the anastomosis can be obtained by testing the blood stream through the anastomosis at the completion of the transfusion by cutting the vein and measuring the flow before ligating the artery, or by severing a communicating venous branch during the transfusion. The blood, as a rule, spurts from this as though it were a branch of the artery itself.

During the past year we have used the Carrel method twelve times in ten patients, one patient being transfused three times. The cases were secondary anæmias with the exception of Case I, which was gas poisoning, and Case V, general septicæmia. The immediate results of the transfusions were good in all except Cases V and XII. In Case V the heart was not equal to the increased burden. In Case XII the hæmoglobin did not rise, although it was shown later that the lumen was satisfactory and there was no thrombosis; on the second attempt the anastomosis was partly obstructed by a small valve-like thrombus, and free hemorrhage from the ulcerated cirsoid aneurism offset the benefit from the limited amount of blood which passed. Cases II, VII, X, and XI were in almost moribund condition and were markedly improved by the operation, apparently owing their lives to the transfusion. They are all now in good health.

Case I.—*Illuminating gas poisoning. Hypostatic pneumonia.*

C. B., New York Hospital, Medical History No. 18007. Age 52. Houseworker. Admitted February 22. Died March 1, 1909. Service of Dr. Peabody.

The patient was found by the ambulance surgeon in a room in which illuminating gas was escaping. She was comatose. Pulse was rapid and extremely feeble. Respirations were four to six per minute when she was brought to the hospital.

*Physical Examination.*—Fairly well-nourished woman, apparently moribund. Pupils dilated and react only slightly to light. Well-marked slow nystagmus. Tongue swollen, congested, and purplish in color. Pharynx congested and contains frothy mucus. Radial pulse almost imperceptible. Neck not stiff. Heart: slightly enlarged, sounds very distant and weak, no murmurs. Lungs: breath sounds feeble, no dulness, and no râles.

Direct transfusion was decided upon. A female patient in the accident ward, who had just recovered from an attack of acute alcoholism, offered her blood and the operation was immediately performed. The left radial of the donor was anastomosed to the median cephalic vein of the right arm of the recipient. The blood was allowed to flow for forty minutes, the vein pulsating all of the time. The patient showed the most marked improvement. Her respirations increased from 5 to 24 per minute. The pulse became full and of a good quality. She, however, did not regain consciousness. A phlebotomy was likewise performed, 34 ounces of blood being withdrawn.

During the ensuing week phlebotomy was done several times, and salt solution per rectum and hypodermic stimulation were given. The day after the transfusion the patient's hæmoglobin was 90 per cent., white blood-cells 26,000, polymorphonuclears 90 per cent. There was albumin in the urine.

The patient gradually developed a hypostatic pneumonia and died without regaining consciousness on the seventh day after admission. Her respirations varied during this time between 24 and 44, pulse rate between 76 and 120.

In regard to the treatment of illuminating gas poisoning by transfusion, the case shows that at least astonishing temporary effects may follow transfusion. The patient was resuscitated from a moribund condition, the respirations and heart action quickly became normal and remained so for several days. The red cells of the donor must have become carriers of oxygen. In this respect the clinical findings were similar to those obtained by Crile in experiments on dogs. If the degree of poisoning is such as to cause cerebral softening, permanent benefit cannot be expected.

CASE II.[1]—*Secondary anæmia—hæmophilia?*

G. M., New York Hospital, Medical History No. 18851. Age two years, 11 months. American. Service of Dr. Conner. Transferred to service of Dr. P. R. Bolton.

*Family History.*—No history of tuberculosis, neoplasm, syphilis, nor hæmophilia in the family of either parent. There is one older and one younger child, neither of whom has shown the slightest tendency to bleed easily.

*Past History.*—The patient is the second child; normal, uneventful delivery. Walked at nine months. Has had none of the diseases of childhood. While teething she had slight intestinal trouble but quickly recovered. When two years old it was noticed that the slightest bruise left an extensive area of discoloration. Five months ago she began to have nosebleed, which sometimes occurred in her sleep. Four months ago she fell, lacerating the upper part of her scalp. Wound was sutured by an ambulance surgeon. That night the wound began to bleed profusely, and she was taken to the House of Relief where the hemorrhage was controlled by deep sutures. The entire upper part of her face became ecchymotic.

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[1] Presented before the Surgical Section of The New York Academy of Medicine, April 1, 1910.

Several severe attacks of epistaxis occurred during the following month which were controlled only after great loss of blood. She was readmitted to the House of Relief August 5, with epistaxis and weakness. August 8, red blood-cells 2,300,000, white blood-cells 18,200, polymorphonuclears 44 per cent., small mononuclears 40 per cent., transitionals and large mononuclears 16 per cent., hæmoglobin 30 per cent.

August 12: She was infused with 100 c.c. of artificial serum. This was followed by a severe chill and by a rise in temperature to 105.2°. The epistaxis which had been almost continuous was checked.

August 14: Red blood-cells 2,180,000, white blood-cells 16,500, polymorphonuclears 26 per cent., small mononuclears 71 per cent., transitionals 2 per cent., large mononuclears 1 per cent., hæmoglobin 25 per cent. No more epistaxis while in hospital. Temperature ranged between 98° and 100°. Urine was normal.

She was transferred to New York Hospital and from there to a Convalescent Home.

October 2: She was brought back to New York Hospital with persistent epistaxis. Physical examination negative excepting for epistaxis, rapid pulse, and ecchymotic spots scattered over the body. Urine negative. Nares were packed with gauze saturated with adrenalin solution, but bleeding was not controlled.

October 4: Red blood-cells 2,300,000, polymorphonuclears 63 per cent., large mononuclears 10 per cent., small mononuclears 16 per cent., transitionals 16 per cent., eosinophiles 3 per cent., basophiles 1 per cent., hæmoglobin 14 per cent., slight polychromatophilia and poikilocytosis. She was infused with 200 c.c. of artificial serum. No further bleeding for 32 hours, when she began to have profuse uncontrollable hemorrhage from the nose which almost exsanguinated her.

October 5: Transfused. Radial artery of the father was sutured to the saphenous vein of the child by the Carrel end-to-end method of anastomosis. Blood began to flow immediately but there was no visible effect on the child for 12 minutes, after which the capillaries in the conjunctivæ and ears became visible, and soon there came a tinge of pink in the child's lips and her hands became warm. At the end of 55 minutes the transfusion was stopped, the child was rosy and warm, lips red, pulse 160 and of good quality. Slight epistaxis of dark red blood began but soon ceased. Hæmoglobin readings taken every 10 minutes showed a steady rise from 14 per cent. to 68 per cent. The general condition of the patient greatly improved. The next day the hæmoglobin was 95 per cent.

Recovery was uneventful excepting for a slight broncho-pneumonia of short duration and some epistaxis and vaginal bleeding. Very slight bleeding occurred twice during the following week, and once a petechial rash appeared on the face after the child strained at stool.

Discharged October 29. Cured. Hæmoglobin 89 per cent.

January 28, 1910: Patient was brought to the hospital. She had just recovered from chicken-pox of the hemorrhagic type. Small black and blue marks were present over the whole body. She had had several hemorrhages, but her condition and color were excellent.

CASE III.—*Secondary anæmia. Carcinoma of stomach(?).*

M. Q., History Number 3409, age 41, single, housekeeper. Admitted to French Hospital, July 23, 1909. Discharged Aug. 12, 1909.

Chief complaint, pain in epigastrium, vomiting, and general weakness.

One year ago the patient began to vomit about ten minutes after taking food. The vomiting was preceded by slight nausea and was not accompanied by pain. It continued for about six months and was independent of the character of the food taken. She lost considerable flesh and became weak. She never vomited blood. For the last six months she has had pain in the epigastrium, especially after eating. The patient enjoyed good health until the present illness.

On admission the woman appeared markedly emaciated, the skin and mucous membranes were very pale. Nothing noteworthy was found on further physical examination. Gastric analysis: quantity extracted one hour after Ewald test meal 30 c.c.; color light tan; large amount of mucus; no free blood. Free acid, none, lactic acid, moderate amount.

White blood-cells 11,000, polymorphonuclears 65 per cent., small lymphocytes 11 per cent., large lymphocytes 16 per cent., basophiles 2 per cent., eosinophiles 6 per cent., hæmoglobin 30 per cent., red blood-cells 2,210,000.

Carcinoma of the stomach was suspected. Since obstructive symptoms were not prominent, as she had ceased vomiting, it seemed wise to do an exploratory laparotomy only if her condition could be improved sufficiently to warrant a resection if this should prove indicated. On August 6, 1909, the patient was transfused. Considerable improvement resulted, but the patient decided to defer operation.

Anastomosis completed and transfusion begun at 1.15 P.M., August 6, and was terminated at 2.10 P.M. Hæmoglobin rose from 30 to 44 per cent.

After transfusion August 6 (7 P.M.), red blood-cells 3,800,000; hæmoglobin 40 per cent.

Aug. 7 (10 A.M.) red blood-cells 4,000,000; hæmoglobin 50%
Aug. 7 (7 P.M.) red blood-cells 4,400,000; hæmoglobin 55%
Aug. 9 (10 A.M.) red blood-cells 4,600,000; hæmoglobin 45%

The patient left the hospital and was told to report for examination later which she failed to do. On March 25, she died at home. No autopsy. It is said by the family physician that for four months she was in fair condition; that during the last three and a half months she failed rapidly, vomited constantly, and had severe epigastric pains.

CASE IV.—*Secondary anæmia, biliary fistula, multiple hemorrhages, senility.*

P. F., French Hospital, History Number 3546, French, age 80, admitted September 21, 1909. Died October 14, 1909.

Chief complaint, swelling and pain in inner part of the left thigh.

*History.*—Seven days ago patient noticed a swelling in the above mentioned region, which gradually increased. There is severe pain at site of swelling, radiating from femoral region to the knee. He is unable to stand. There is no history of trauma. Appetite good, bowels regular, urinates three to four times daily and two or three times at night. Two days ago he says he vomited a cupful of blood.

Never had similar trouble before. Two years ago patient was operated upon for gall-stones, and the wound never closed. Has had a right inguinal hernia for 30 years. Denies urethritis and syphilis.

*Physical Examination.*—The scrotum, penis, and inner and posterior surface of the left thigh to the knee are ecchymotic. There is a globular swelling below Poupart's ligament on the left thigh about three inches in diameter. It is tense and tender on pressure, flat on percussion, and has no bruit. Over most of the ecchymotic area there is induration which does not pit on pressure.

The man is thin and anæmic; the arterial walls are thickened. There are a few crepitant râles and dulness at right apex in front. In the scar of gall-bladder operation there is a fistula discharging bile very freely. Just above Poupart's ligament on the left side there is a small reducible inguinal hernia. He is unable to move his left leg.

On September 23, 1909, an incision was made over the swelling on inner part of thigh; it proved to be a hæmatoma. Blood oozed intermittently from the wound. Horse serum was administered subcutaneously on three successive days without effect. There was no fever at any time; cultures of fluid from hæmatoma were sterile. Blood examination October 11, hæmoglobin 18 per cent., red blood-cells 1,856,000, blood-pressure 94 mm.

The patient was transfused on October 12, 1909; anastomosis completed and flow begun at 11.47 A.M.; flow discontinued at 12.50 P.M. Hæmoglobin rose from 18 per cent. to 39 per cent.

After transfusion: October 12 (7 P.M.) hæmoglobin 48 per cent., red blood-cells 2,380,000, blood-pressure 112 mm.

October 13 (10 A.M.) hæmoglobin 50 per cent., red blood-cells 2,900,000, blood-pressure 110 mm.

October 14, the patient had a profuse rectal hemorrhage, and died soon afterwards. No autopsy.

CASE V.—*Septic endocarditis. Septicæmia.*

A. R., New York Hospital, Medical History No. 18344.

Age 22. Milliner. Austrian. Admitted March 13, 1909. Service of Drs. Conner and Lambert. Died September 30, 1909.

*Past History.*—Has had no previous acute illness. No history of joint symptoms, nor sore throat. When ten years old a swelling in her neck was first noticed and she thinks that it has not grown larger since then. Thinks eyes have never been bulging; she has been nervous and excitable, and frequently has had palpitation of the heart.

Uses beer and wine moderately. Usually constipated.

No history of syphilis or gonorrhœa.

Present illness began two months ago with headache, and sharp pains in legs but not in the joints. This was soon followed by anorexia, nausea, and sharp pain over the whole abdomen which came on immediately after eating and lasted from one to two hours. At times swallowing was difficult, and she vomited sour smelling fluid which had never to her knowledge contained blood. Has had occasional sticking pains over her heart and for some time constant severe pain in the left side of abdomen.

Recently has had chilly feelings and night-sweats. No cough nor difficulty in breathing. No urinary symptoms, swelling of feet, or ankles. Has not been jaundiced. Complains of feeling very tired and weak.

*Physical Examination.*—Fairly well-nourished girl. Skin and mucous membranes good color. Eyes normal. Tongue moist, coated. Pharynx normal. Neck not stiff. Slight enlargement of the thyroid but no thrill nor bruit present. Diastolic pulsation is present in large veins. Systolic murmur in carotids. Pulses equal, regular, good size and force, moderate tension, Corrigan in type. Vessels not sclerosed. Capillary pulse in nails. Heart is enlarged, gallop rhythm, prolonged rather rough diastolic murmur over aortic area. Second pulmonic accentuated. No thrills felt. Lungs normal. Abdomen soft, not tympanitic. No masses. Liver tender on percussion, normal in size. Spleen not enlarged. Kidneys not palpated. Extremities, knee-jerks greatly diminished. No œdema. No enlargement of the superficial lymph-nodes. Temperature 101.8°, respirations 24, pulse 120. Urine examination shows absence of sugar and albumin. Hæmoglobin 66 per cent., leucocytes 9000, polymorphonuclears 79 per cent., lymphocytes 21 per cent.

Blood culture taken on May 18 showed a pure culture of streptococcus. On the third day after admission she developed a systolic murmur at the apex, and on the fifth day petechial spots appeared on the front and back of chest. Abdomen became very tender and rigid. May 22 she began to receive a vaccine made from the organism obtained from her blood.

In spite of all treatment with different varieties of homologous vaccines and the usual therapeutic measures, the disease ran its course with typical waves of improvement alternating with periods of exacerbation, the up-and-down septic temperature, enlarged spleen, nephritis, petechiæ, etc.

Her brother, a healthy young man, consented to be the donor for a transfusion. He was prepared by vaccination with the vaccine made by Dr. Elser, pathologist to the New York Hospital, from the streptococcus of her blood, the purpose being to produce antibodies in his blood antagonistic to that organism.

September 11, 1909. Transfusion. Service of Dr. Bolton. Several ounces of blood were first drawn from the patient's veins. The radial artery of the donor was then sutured to the left internal saphenous vein of the recipient. The anastomosis was perfect; blood flowed freely and apparently at a good volume. After ten minutes the patient became restless, irrational, cyanosed, her pulse rapid and irregular, and respirations rapid and almost stertorous. It seemed extremely dangerous to continue, so the transfusion was immediately stopped. She was stimulated by hypodermic injections and in a few hours she had recovered fairly well.

During the next week the patient developed general œdema. Showers of emboli, causing pain in the internal organs, and petechiæ continued, and the patient's asthenia became marked. She died on the nineteenth day after transfusion, after an illness of almost eight months. No autopsy.

CASE VI.—*Secondary anæmia following puerperal septicæmia.*

V. M., French Hospital, History Number 3665, married, age 30, Italian, housewife. Admitted October 22, 1909, discharged December 3, 1909.

For the last seven weeks, patient has complained of pain in left side of abdomen and back, pain is severe in character and radiates over lower part of abdomen. Urinates somewhat too frequently, bowels irregular, appetite poor. She has lost considerable weight and feels very weak.

Was operated upon elsewhere, on August 31, 1909, for "puerperal septicæmia." The operator sends the following details: "Temperature 105°, pulse 130, respirations 30 before the operation. There was a large intramural abscess on the left side, extending into broad ligament and including left tube and ovary. The sigmoid was included in adhesions and slightly eroded. Patient's condition permitted only a rapid laparotomy and drainage. Fecal fistula appeared on fourth day. After operation and for some days subsequently, the pulse ran from 136 to 128. Temperature 104° to 100° and respirations 60 to 30."

*Physical Examination.*—Patient is very feeble, pale, and emaciated. Heart negative. There are a few sibilant râles at the right apex. Abdomen: There is a wound about three inches long in the left lower quadrant of the abdomen discharging pus and fæces. The entire abdomen is tender to palpation, especially on the left side where a mass is indefinitely felt. By vagina extensive induration is appreciable in the left side of pelvis. There is a profuse purulent vaginal discharge.

Urine: Turbid, flocculent precipitate, specific gravity 1026, acid, albumin present, considerable pus and amorphous urates. Blood examination on October 24, hæmoglobin 30 per cent.; red blood-cells 2,384,000; white blood-cells 8500; polymorphonuclears 74 per cent.; small lymphocytes 20 per cent.; large lymphocytes 3 per cent.; basophiles 2 per cent.; eosinophiles 1 per cent.

The patient's condition was so poor that a transfusion was done in the hope of making her better able to stand an operation. Improvement was marked and operation was repeatedly deferred.

Transfusion, October 25, 1909. Anastomosis completed and flow begun at 11.07 A.M.; flow discontinued at 11.58 A.M.

| | Time | Recipient |
|---|---|---|
| Blood-pressure (systolic) | 10.00 A.M. | 110 mm. |
| | 11.20 A.M. | 124 mm. |
| | 11.40 A.M. | 115 mm.[2] |
| | 12.00 M. | 150 mm. |

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[2] At this sudden fall in blood-pressure apex of heart had moved ½ inch to left; volume of flow was diminished for five minutes and heart gradually resumed its normal outlines.

| | Time | Recipient |
|---|---|---|
| Pulse | 10.00 A.M. | 108 |
| | 10.30 A.M. | 104 |
| | 11.00 A.M. | 96 |
| | 11.30 A.M. | 92 |
| | 12.00 M. | 84 |
| | 12.15 P.M. | 88 |
| Hæmoglobin | 10.00 A.M. | 34 per cent. |
| | 11.15 A.M. | 45 per cent. |
| | 11.40 A.M. | 47 per cent. |
| | 12.00 M. | 50 per cent. |
| | 12.15 P.M. | 50 per cent. |

After cutting vein, three drachms of blood flowed in fifteen seconds.

Oct. 25 (8 P.M.): Hæmoglobin 54 per cent.; red blood-cells 3,608,000; bood-pressure 119 mm. Improvement continued steadily until Nov. 1, when hæmoglobin was 62 per cent.; red blood-cells 4,600,000; from the 1st to the 20th there was a steady fall; November 20, hæmoglobin 42 per cent.; red blood-cells 3,300,000. No operation was performed, and at the time of her discharge the fecal fistula was almost closed, the pelvic and abdominal masses had greatly diminished, and her general condition was so good that she was able to return at once to her household duties.

TRANSFUSIONS VII, VIII, and IX.[3]—*Anæmia* (transfused three times).

M. T., French Hospital, Admission Number 15,399, age 43, French, married, housewife. Admitted December 29, 1909.

*Present History.*—Onset, 14 days ago, began with violent headache, pain in back, over heart, and in epigastrium, and extreme weakness; a day later slight jaundice appeared; she has been confined to bed since onset.

*Previous History.*—In 1896 patient had menorrhagia for which she was curetted; in 1900 she was operated upon for an abscess on the left side of thorax; in 1902 she had rheumatism which confined her to bed one month. She has had at times a distressing cough and dyspnœa for a number of years, also palpitation on the slightest exertion, but no night-sweats, chills, or fever; she has had œdema of legs for nine years, gradually increasing to date; also frontal headaches, worse at night and throbbing in character, spots before the eyes, vertigo, and tinnitus for the past three or four years. Gives no history pointing either to gonorrhœa or syphilis. For past two years patient has been under severe mental strain. Eighteen months ago she began to lose her color, the pallor has gradually increased. Menses began at fourteen years and were regular until 25 years of age, since then they have been profuse much of the time, lasting five to eight days, and making her very weak for some time following. The menorrhagia has been especially marked recently. Married at twenty-five; two children living and well; no miscarriages. Habits good.

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[3] Presented before the New York Surgical Society, May, 1910. We are indebted to Dr. Shanley, house surgeon of the French Hospital, for the records of the cases at that institution.

*Physical Examination on Admission.*—Woman of medium size, apathetic, and aroused with difficulty. Face expressionless, mucous membranes colorless, lips dry, parched, and brown, conjunctivæ slightly yellow, skin has a lemon tint and is bloodless, superficial veins show conspicuously as dark blue lines. Radial pulse not palpable, heart sounds very feeble. The woman appears moribund. Blood examination shows 600,000 red blood-cells and 16 per cent. hæmoglobin. Urine, December 29, 1909: turbid, amber, flocculent precipitate, specific gravity 1016, acid, no sugar, moderate amount of albumin, numerous epithelial and red blood-cells, few white blood-cells, many hyaline and granular casts.

Transfusion was immediately done, taking the husband as donor, although he was weak and anæmic. There was moderate improvement. The next day a second transfusion was made, taking a young man as donor. Marked improvement resulted. Cheeks became flushed, lips of a normal color. The recipient, however, became extremely restless and it was necessary to stop. Afterwards she became delirious and two days later showed extreme jaundice.

The third transfusion was done ten days later, as the patient's blood and general condition had begun to show a marked change for the worse. A healthy young man was used as the donor. Considerable and prolonged improvement resulted.

Record of *first transfusion,* December 29, 1909:

Before transfusion, red blood-cells 600,000, hæmoglobin 16 per cent., blood-pressure 100 mm.

Flow begun at 1.21 P.M., discontinued at 2.15 P.M.

| | | Donor | Recipient |
|---|---|---|---|
| Blood-pressure | Beginning | 130 | 99 |
| | End | 119 | 128 |
| Pulse | Beginning | 88 | 128 |
| | End | 92 | 122 |
| Hæmoglobin | Beginning | 71 per ct. | 16 per ct. |
| | End | 57 per ct. | 22 per ct. |
| Red blood-cells | Beginning | 3,600,000 | 600,000 |
| | End | 2,700,000 | 928,000 |

December 29, 7 P.M.: Red blood-cells 1,008,000, hæmoglobin 21 per cent., white blood-cells 42,000, polymorphonuclears 69 per cent., small lymphocytes 16 per cent., large lymphocytes 13 per cent., basophiles 2 per cent., megaloblasts 5 per cent., normoblasts 7 per cent., marked poikilocytosis, numerous umbilicated red cells. Stools negative for ova, occult blood, etc.

*Second transfusion,* December 30, 1909. Transfusion flow begun at 5.03 P.M., discontinued at 6.11 P.M.

After transfusion vein was cut and in 14 seconds there flowed 110 minims.

| | | Donor | Recipient |
|---|---|---|---|
| Blood-pressure | Beginning | 128 | 111 |
| | End | 100 | 136 |
| Pulse | Beginning | 82 | 120 |
| | End | 124 | 104 |
| Hæmoglobin | Beginning | 81 per ct. | 19 per ct. |
| | End | 65 per ct. | 33 per ct. |
| Red blood-cells | Beginning | 4,100,000 | 1,015,000 |
| | End | 3,018,000 | 1,952,000 |

Subsequent to transfusion: December 31, 7 P.M.: Red blood-cells 2,288,000, hæmoglobin 35 per cent., white blood-cells 18,700, polymorphonuclears 72 per cent., small lymphocytes 8 per cent., basophiles 1 per cent., normoblasts 6 per cent., megaloblasts 3 per cent., marked poikilocytosis and numerous umbilicated red cells.

January 9: Red blood-cells 1,236,000, hæmoglobin 25 per cent., white blood-cells 11,900; otherwise the counts taken each day were about the same as that last given.

*Third transfusion,* January 10, 1910. Flow begun at 6.16 P.M., stopped at 6.55 P.M.

| | | Donor | Recipient |
|---|---|---|---|
| **Blood-pressure** | Beginning | 120 | 92 |
| | End | 102 | 125 |
| **Pulse** | Beginning | 72 | 136 |
| | End | 92 | 120 |
| Hæmoglobin | Beginning | 100 per ct. | 23 per ct. |
| | End | 94 per ct. | 56 per ct. |
| Red blood-cells | Beginning | 5,150,000 | 1,184,000 |
| | End | 3,746,000 | 1,386,000 |

After this the patient did fairly well, although she developed a pneumonia in lower right base and later pleurisy with effusion on left side. This made necessary repeated tappings (10 in all), at times 20–30 ounces of clear or blood-tinged fluid being removed.

March 5: Von Pirquet test negative.

March 13: Patient has been up for some days, can walk, has fair appetite, and feels well. Urine occasionally shows trace of albumin. Red blood-cells 2,624,000, hæmoglobin 70 per cent.; the blood is otherwise normal.

May 7: Patient in good condition, hæmoglobin 70 per cent.; red blood-cells 3,150,000.[4]

CASE X.—*Papilloma of bladder. Excision. Secondary anæmia.*

J. S., the Post-Graduate Hospital, service of the late Dr. Follen Cabot. Male, age 34 years. Admitted January 20, 1910.

Chief complaint, pain in left side of abdomen and bloody urine.

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[4] The cause of the anæmia in this case could not be definitely determined.

Dr. N. B. Potter, who supervised the treatment much of the time, wrote, "Her blood picture has not been one of typical pernicious anæmia; how much, however, it has been altered by the transfusions no one can say. Very grave anæmia with a persistently high color index is as near as I can get."

Dr. F. C. Wood wrote, "I would not like to make a positive diagnosis of pernicious anæmia on the smears, but would prefer to call the condition a secondary anæmia."

*Past History.*—Has had several previous attacks of hæmaturia, otherwise the history is unimportant.

*Present Illness.*—Blood appeared in the urine nine days ago and has been steadily increasing in amount since. There has been pain in the left lumbar region and in the end of the penis during urination. Patient has had great difficulty in urinating during the past three days.

*Physical Examination.*—Patient is a large, well-nourished Italian, showing nothing abnormal on external examination excepting extreme pallor. Specimen of urine contains almost pure blood.

Operation by Dr. Cabot, January 21. Suprapubic cystotomy. Excision of papilloma of the bladder. Rubber drainage tube left in the bladder. Operation begun with eucaine local anæsthesia and completed under nitrous oxide gas anæsthesia. Duration, one hour. General condition of patient very poor. Pulse weak and rapid after the operation.

Five and a half hours after the operation the patient was comatose and practically moribund. Hæmoglobin 34 per cent., red blood-cells 1,500,000, pulse 156 per minute.

Transfusion was performed by one of us (R. D. McC.) with the assistance of Dr. Aspinwall Judd. The donor was a brother and of only about two-thirds the stature of the patient. The right radial artery of the donor was anastomosed to the left internal saphenous of the recipient. The vessels were exposed and anastomosed in 28 minutes. The blood was allowed to flow 40 minutes.

The following table was made during the operation. At 5.30 P.M. flow of blood started.

| | Hæmoglobin | Pulse |
|---|---|---|
| 5.40 P.M. | 36 per cent. | 132 |
| 5.45 P.M. | 42 per cent. | 126 |
| 5.50 P.M. | 53 per cent. | 126 |
| 5.55 P.M. | 54 per cent. | 126 |
| 6.00 P.M. | 58 per cent. | 126 |
| 6.05 P.M. | 62 per cent. | 126 |
| 6.10 P.M. | 62 per cent. | 126 |

Transfusion ended, 6.10 P.M.

The patient's general condition and color underwent marked improvement during the transfusion. The transfusion would have been continued but the donor began to show the effect of the loss of blood. He became very pale, restless, and nauseated. Eight P.M., the same day, hæmoglobin 64 per cent., pulse 140.

January 22, 10 A.M.: Red blood-cells, 3,320,000, hæmoglobin 76 per cent. General condition is greatly improved and patient is mentally much brighter.

January 26: Red blood-cells 3,170,000, hæmoglobin 71 per cent.

February 11: Red blood-cells 3,616,000, hæmoglobin 75 per cent (Talquist).

All of the previous readings had been taken with the Dare hæmoglobinometer. March 3d. Red blood-cells 4,112,000, hæmoglobin 75 per cent. (Talquist). The condition of the patient is good and he is ready to leave the hospital.

CASE XI.[3]—*Infected fibroid of uterus. Suppurative metritis. Multiple metastatic abscesses of thigh. Pyæmia.*

New York Hospital, service of Dr. Bolton. Surgical History No. 38,247, Mrs. J., 35 years, admitted August 3, discharged November 4, 1909.

*Past History.*—Has always been strong and healthy. Menstruation began at seventeen years of age, regular, every five weeks, not painful. Married at twenty-one. First three pregnancies terminated successfully.

*Present Illness.*—On July 7 patient had a miscarriage and stated that it was not induced. Her last period had been in May. Following the miscarriage she had persistent bleeding and the discharge soon became very foul. She had chills and a high fever. She became so ill that she did not remember much about the early part of her sickness. Her physician gave her intra-uterine douches. Bleeding soon stopped, but she continued in a very serious condition and was brought to the hospital.

*Physical Examination.*—Patient is an extremely anæmic woman. She is weak and appears septic. Head: face and mucous membranes are almost bloodless. Tongue is slightly coated, teeth are very bad. Heart percusses normal. Sounds are distant and weak and there is a systolic murmur at apex, transmitted toward axilla, not well heard in back. Lungs:

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[3] Presented before the Surgical Section of The New York Academy of Medicine, April 1, 1910.

normal. Abdomen: not distended or tender. Just above the symphysis and to the right of midline, there is a slight rounded prominence. On palpation it is found to be firm and freely movable. There is a slight resistance above the limit of this mass.

*Vaginal Examination.*—Outlet normal for multipara. Marked discharge of pus. The cervix is large and soft. The external os is dilated and emits a profuse discharge of pus. Bimanual examination reveals a large, firm, elastic, fairly movable mass without fluctuation extending upward from the right side of the uterus. Tubes and ovaries are indefinitely palpable.

Temperature 102°, pulse 124, respiration 28. Hæmoglobin 30 per cent., leucocytes 40,000, polymorphonuclears 84 per cent., mononuclears 13 per cent., transitionals 3 per cent. The red cells show considerable poikilocytosis. No nucleated reds found.

The general condition of the patient was such that it was thought she could not stand an operation. She did not improve under treatment but became weaker. October 9 her white blood-cells numbered 16,000, and her temperature reached 104.8°.

A brother willing to give his blood offered himself and a transfusion was decided upon. Patient's hæmoglobin was now 18 per cent.

August 10: Transfusion was unsuccessfully attempted by others by Hartwell's implantation method, with a Crile cannula and by suture. Clotting occurred in the first two attempts, considerable hemorrhage in the last, which was not controlled until a clot had formed.

August 11: Transfusion was performed following Carrel's technic of end-to-end blood-vessel suture. The right radial of the donor and the right internal saphenous vein of the patient were prepared under local novocaine anæsthesia. Anastomosis was easily made. There was slight bleeding at the line of union, but this quickly stopped without further suture. Pulsations were palpable in the vein. The calibre of the vein remained small for about fifteen minutes, when the vessel began slowly to dilate and the blood flowed more freely. The hæmoglobin rose gradually but with a marked acceleration toward the end of the operation, from 18 to 40 per cent. The transfusion was stopped when the donor became restless and vomited several times. The patient's mental condition had improved.

Her lips at the beginning were colorless, but were now red and her cheeks had gained a healthy pink.

The anastomosis was opened and found perfectly patent. No thrombosis. The afternoon of the transfusion a dull curettage was done and some tissue and considerable pus were brought away. Uterine irrigation given. The pathologist reported the specimen to be well-preserved muscle tissue. For a few days the condition of the patient was excellent, but soon she became weaker and her hæmoglobin dropped within six days to 18 per cent., the same as before transfusion. Spectroscopic examination failed to reveal a trace of bile or blood pigments in urine. On August 15 her general condition was about the same as before transfusion. The mass in the lower abdomen was markedly diminished in size, and there was an absence of tenderness and rigidity in lower abdomen. White blood count, 24,000, polymorphonuclears 84 per cent., red blood-cells 1,800,000, temperature ranged around 101°. Transfusion wounds healed.

The following abstracts from the bedside notes outline the subsequent course.

August 17: General condition is very much improved. She takes food by mouth and retains nutrient enemata. She feels much stronger. Discharge from vagina remains profuse with extremely unpleasant odor. Small necrotic mass expelled from uterus. Uterine tumor much decreased in size.

August 29: Very slight uterine discharge. Uterus is now small, fairly firm, and movable. Mass is no longer felt in its wall. Cervix normal. Hæmoglobin is rapidly rising. Yesterday she had two chills, followed by elevation of temperature to 105°, accompanied by severe nausea and vomiting.

September 12: Hæmoglobin 50 per cent. Patient feels stronger and looks better, though she has had numerous chills with sudden rises and falls of temperature during the last few days.

September 29: Pain has persisted in the right thigh and calf. There is slight swelling with some fluctuation and increased surface temperature on inner side of right thigh just above the knees. She has been having chills and considerable fever.

September 30: Incision made over inner side of right thigh and a considerable quantity of pus evacuated. Drainage.

October 8: A few petechiæ have appeared on chest, arms, and back. Daily rise of temperature and frequent chills persist. The petechiæ followed an attack yesterday in which she complained of a peculiar sensation over entire body, and pain in back which lasted about six minutes. Over bases of both lungs are subcrepitant râles and a few râles are present anteriorly. No pain over spleen or kidney regions. Patient vomits frequently and vomitus contains bile. Sinus is discharging freely. Pathologist reports original culture from thigh sterile. Hæmoglobin has gone down to 45 per cent. Blood cultures continue negative.

October 15: Temperature has been normal for two days, and she feels much better and is taking more food. Sinus is healing slowly. She is now receiving dead staphylococci injections with no local or general reaction.

October 23: Gaining in strength daily. Has had no rise of temperature for five days. Is now taking food of from 1800 to 2200 calories value daily as advised by Dr. Conner.

October 31: Is now able to walk with assistance. Hæmoglobin 53 per cent.

November 4: General condition good. No pain, fever, or chills. Is gaining in weight and is able to walk alone. Pelvic examination negative. Uterus normal in size and there is no discharge. No tenderness on palpation. Wound in thigh is practically healed.

Diagnosis: Infected myoma of uterus, suppurative metritis. Metastatic abscess of thigh, septicæmia? Result: Cured. Patient discharged to go to the country.

Patient seen in December, is in perfect health. Has gained in weight even to excess. Color is that of a robust healthy woman.

CASE XII.—*Secondary anæmia, following hemorrhage from cirsoid aneurism of face.*

I. G., New York Hospital. Surgical History No. 39,607. American girl, age 22. Admitted February 18, 1910. Service of Dr. Hartley.

Patient was born with a large vascular nævus over the left side of face, involving also the left ear which has always been larger than the right. The nævus grew and greatly disfigured the face and ear. Five years ago both carotid arteries were ligated. Since then the mass has steadily increased in size, though more rapidly during the past two years. Eighteen months ago the ear became ulcerated, and foul-smelling pus has been continually discharged. Several severe hemorrhages have been checked with the greatest difficulty.

She is now suffering from pain, loss of appetite, loss of weight, nervousness, and anæmia.

*Physical Examination.*—Rather large girl with marked anæmia. There is a large pulsating tumor involving the left side of the face, scalp, and ear, which is about five times the natural size and much distorted. Immediately under the skin the tortuous outlines of large vessels are plainly visible. The lower half of the growth is ulcerated and emits a foul odor. The auditory canal is obliterated, and the sense of hearing is absent on this side. A loud systolic murmur is heard over the entire surface of the growth.

After admission to the hospital several hemorrhages occurred which were checked only by tight bandaging. Anæmia became marked and weakness extreme. Hæmoglobin readings fluctuated between 19 and 40 per cent.

On February 21 transfusion was performed. The donor was a highly neurotic sister who so excited the patient during the operation that an almost fatal hemorrhage occurred. The radial artery was first anastomosed to the saphenous vein near the ankle. As the flow was not satisfactory, a second anastomosis was made with the cephalic vein.

The transfusion resulted in little benefit, the hæmoglobin at the end reading only a few points higher than at the beginning. The loss of blood during the transfusion as the result of hemorrhage from the ulcer was very free, therefore it is likely that the hæmoglobin readings were not a true index of the amount of blood which passed.

The patient was discharged from the hospital March 29 unimproved.

# BLOOD TRANSFUSION IN HÆMOPHILIA.*

BY CHARLES GOODMAN. M.D.,

OF NEW YORK,

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THE following case is reported as an evidence of the importance of blood transfusion in the treatment of hæmophilia.

The patient in question, a male, is two and one-half years of age, and is the third of four children, two of whom are females. He was admitted to the Beth Israel Hospital on July 10, 1909, twenty-four hours after having fallen from a fire-escape to the landing below. The child had sustained a lacerated wound of the right cheek, which was surrounded by a hæmatoma involving the entire right side of the face and extending to the lower eyelid. The buccal mucous membrane was lacerated in several places, and the upper lip completely severed. The latter had been sutured before admission to the hospital. Blood was oozing from all the wounds of the mouth and cheek.

A further examination of the child revealed the fact that the surface of the body was almost completely covered anteriorly and posteriorly with ecchymotic spots, varying in size from a ten-cent piece to a half dollar.

The patient was a fairly well-developed child for its age, but was exceedingly pale and appeared to have lost considerable blood. Upon inquiry into the history, the mother volunteered the following information:

" The child almost from birth showed a tendency to develop black and blue spots on the body upon the slightest injury. These spots often appeared after mere contact with some hard object, and would last from six to eight weeks. Ritual circumcision, performed on the eighth day after birth, was followed by continuous bleeding for several days. This was finally checked after several physicians had been called in, but not until the child was so exsanguinated that its life was despaired of. One year ago the child cut its finger and the wound bled for two weeks. About eight months ago the child fell and cut its gums, and this wound continued to ooze for several months."

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* Patient presented before the Surgical Section of the New York Academy of Medicine, at the stated meeting held Nov. 5, 1909.

Neither a history of consanguineous tie in the family nor that of hemorrhagic diathesis could be elicited.

The temperature of the child upon admission was 98.4°, pulse 150, urine was negative. During the first two days, the following measures were used to check the bleeding: application of adrenalin chloride, nitrate of silver, ice, and pressure with pledgets of gauze. Calcium chloride was administered by mouth, also tr. ferri chloridi. These were followed by calcium lactate and saline solution per rectum, and saline hypodermoclysis. On the morning of the second day 20 c.c. of diphtheria antitoxin were administered in two doses hypodermatically.

During the first day in the hospital the child vomited several times, bringing up several ounces of blood. On the following day he had several blood-stained movements.

In spite of all the measures used, the oozing continued, and although the loss of blood at times seemed insignificant, the child appeared to be getting weaker and weaker, as the pallor of the skin and mucous membrane became progressively more marked.

The transfusion of healthy blood was considered, and a donor sought for. The mother volunteered, but being at that time in her eighth month of pregnancy, and in view of the possibility of her having been responsible for the peculiar dyscrasia in the patient, was rejected. The father likewise was not considered, as he was poorly nourished, delicate, and anæmic, and could not have stood the loss of blood. A donor was readily obtained in a healthy applicant, nineteen years of age.

While Dr. J. J. Hertz, of the bacteriological department of the hospital, made the preliminary hæmolytic and the Wasserman and Noguchi tests, 5 c.c. of fresh serum obtained from a live rabbit was injected.

For a few hours the oozing from the wounds seemed to stop, but on the following morning, July 13, the little patient was in a distressing condition. He was apathetic and semicomatose, and his respirations labored and gasping. The temperature was 102°, and the pulse, which during the night had reached 180, had now become imperceptible. The tongue protruded, and the patient was so weak and exhausted that he could not swallow any nourishment. The skin was decidedly waxy in appearance, the mucous membranes were slightly cyanotic.

The blood at this time, showed hæmoglobin 12 per cent., and less than 1,000,000 erythrocytes. The donor was quickly summoned and brought to the operating room with the child, and each was placed on the operating table ready for transfusion. The child was given one-eighth grain and the donor one-quarter grain of morphine hypodermically. For the exposure and dissection of the left radial artery of the donor I used a solution of ¼ per cent. cocaine; to an ounce of this solution ten minims of adrenalin 1 : 1000 had been added. After having dissected what I thought was the radial artery, I was perplexed on account of its small size and entire absence of pulsation in this vessel, and for a time I thought that I had to deal with an anomalous condition of the blood-vessels. The radial vein seemed a mere thread in size. I severed the artery and applied hot saline pads. At first three or four drops of blood appeared, and then there followed a good spurt of bright red blood. The Elsberg cannula was then applied. The distal end of the artery was cuffed over the cannula with the aid of the little tenacula designed for that purpose, and covered with saline pads. The femoral vein of the child was now rapidly exposed and lifted by two ligatures, the distal one being tied. This dissection was carried out without any anæsthesia, and there was no apparent objection on the part of the child, which lay almost lifeless on the table. I succeeded in introducing the cannula into a lateral opening of the femoral vein and opened the cannula.

After ten minutes there was a very slight change in the color of the lips, but there was only an occasional flutter of the child's pulse. The operating tables were of unequal height and could not be properly adjusted to favor an uninterrupted anastomosis, so I abandoned the femoral vein, and decided to try the upper extremity of the child. The basilic vein of the right arm was rapidly exposed, and although the vessel was of small calibre I succeeded with the aid of the little tenacula in introducing the cannula, holding the cuffed artery into this lumen. In the course of ten minutes the child showed the effects of the transfused blood by a gradual return of pulse and color. The transfusion was continued for twenty-eight minutes. At the end of that time, the pulse was regular, of good quality, and 140 in frequency. The ears, cheeks, and lips, previously waxy, had now become pink. The hæmoglobin taken and measured with the Talquist scale recorded 70 per cent. and the child, previously having the appearance of a limp, lifeless body, was now transformed into a healthy living being. He became restless, and begged for nourishment.

It was indeed a dramatic moment as we watched the new blood gradually and surely enter the vessels of the subject, and give it a new lease of life. The donor was not greatly inconvenienced by the ordeal, and although obliged to remain in an absolutely quiet position for a prolonged time in the operating room, behaved like a stoic and stood the ordeal unflinchingly.

About an hour and a half after transfusion there was a sudden rise in the temperature to 106.4°, and a pulse of 190. This gradually subsided without treatment, and 12 hours later was 99, and the pulse 140. The child partook of nourishment, and with the exception of a slight temperature, due to some infection of the wound in the thigh due to derangement of the dressing, made an uninterrupted recovery.

The principal points of interest noted were that the oozing from the wounds was not only interrupted by the transfusion but absolutely checked by it. The ecchymotic spots which had covered almost the entire body of the child gradually faded away. With the exception of one spot on the forehead which appeared as a result of a fall, no new ecchymotic spots were observed. The spot disappeared in the course of a few days instead of remaining visible for weeks as formerly. He has not vomited nor passed any blood since the transfusion.

The patient when discharged from the hospital on the twenty-eighth day of July showed a red blood count of 3,400,000, and a hæmoglobin of 60 per cent. After spending three weeks at the sea-shore, the child was brought back to the city, and an examination of his blood showed 5,000,000 erythrocytes, and 80 per cent. hæmoglobin. He has since then passed through a normal course of measles without complications. More recently, following an infected scalp wound, cellulitis developed, which required extensive incisions for proper drainage. The wounds healed gradually without showing any tendency to hemorrhage.

In conclusion the following point of interest should be mentioned: The mother gave birth to her fourth child in August, 1909. Notwithstanding the trying experience with the first male offspring, the parents had the infant circumcised on the eighth day. The infant was brought to the hospital ten days later to be treated for continuous bleeding from the wound. The two female children of this family show no tendency to bleed.

# GRAFT OF THE VENA CAVA ON THE ABDOMINAL AORTA.

BY ALEXIS CARREL, M.D.,

OF NEW YORK.

(From the Laboratories of the Rockefeller Institute for Medical Research.)

I. INTRODUCTION.—The operation consisted of transplanting between the cut ends of the abdominal aorta a segment of vena cava. Its purpose was to study the details of the technic of the graft of a large vein on the aortic trunk and its remote results. It is important to know whether venous segments can replace parts of the aorta as successfully as parts of smaller arteries, the carotid for instance. Five years ago, I advocated the use of venous grafting in the treatment of aneurisms and of certain traumatic lesions of arteries.[1] It was warranted by the results of experiments that I had performed in 1902 in Lyons with Morel[2] and in 1905 in Chicago with Guthrie.[3] These experiments had shown that arteriovenous anastomoses made with a proper technic remain normal, and that a vein, transplanted on an artery, reacts against the increase of blood-pressure by thickening its wall. They demonstrated that veins can be safely grafted on arteries. At this time, it was believed that the successful arterial transplantation of a vein was not possible. Exner[4] had attempted several times to graft a segment of jugular vein on the carotid artery. The vein always became occluded. The results of Hoepfner[5] and of Goyanes[6] had also been negative. Payr[7] concluded that thrombosis was due to the action of the arterial blood-pressure on the thin venous wall, and that this biological factor rendered impossible the success of a venous transplantation. A short time afterwards, I was able to repeat these experiments at the University of Chicago. I found immediately that the thrombosis observed by previous experimenters was not due to a biological but merely to a surgical cause, and that, with a proper technic, positive results could easily be obtained. Our experiments of 1905 and 1906 showed that arteriovenous anastomosis remained normal after twenty months. They also permitted the study of anatomical modifications of the venous wall under the influence of the increased blood-pressure. Eight months after the graft of a segment of jugular on the carotid, the circulation was found to be normal through the vein, the wall of which had become as resistant as an arterial wall.[8] It was, therefore, certain that veins followed the law of adaptation of organ to function, and that they could, when they were compelled to do so, play the rôle of arteries. In other experiments, made in 1907 and 1908 at the Rockefeller Institute, I was able to follow more closely the histological evolution of segments of jugular vein transplanted on the carotid, and observe that twenty months after the operation the venous segment was still in excellent condition.

These results have been confirmed by other experimenters in America and Europe. In 1907, in the laboratory of Harvey Cushing at Johns Hopkins University, Watts[9] performed several times the graft of a segment of jugular vein on the carotid artery. He found that the vein adapted itself to arterial function. Stich,[10] during the experiments made in 1907 and 1908 in the Klinik of Garré, was able to follow the evolution of a venous segment grafted on a carotid artery for 409 days. Fischer and Schmieden[11] also obtained positive results. In 1909, at the Pasteur Institute, Frouin[12] performed some arteriovenous anastomoses which became occluded after a few months. He did not realize that the occlusion was due to his defective technic, and concluded that it was the normal evolution of the anastomoses.

The information given by these experiments has been used only twice in human surgery. Goyanes performed, in 1906, an incomplete transplantation of the popliteal vein on the popliteal artery after extirpation of an aneurism, and his patient recovered. In 1907 in a case of axillary aneurism, Lexer[13] performed a graft of a segment of saphenous vein, but his patient, whose general condition was very bad, died after a short time. On human beings, the technic of the arteriovenous anastomoses is easier than on dogs. They should be as successful, if they are performed with a proper technic and when the anatomical conditions of the artery allow it.

From an experimental stand-point the transplantation of venous segments can yield excellent results, even after a long time, when the operation is performed on dogs' carotid arteries. It is important to know whether these results will be different in case of larger and more friable vessels in which the blood-pressure is higher.

II. Technic and Experiments.—The animals were etherized and their abdomens opened by a transverse semicircular laparotomy. The graft of the vena cava to the aorta was composed of four stages.

1. *Extirpation of a Segment of Vena Cava.*—At a short distance below the mouth of the renal veins, the vena cava was dissected and isolated between two ligatures. A venous segment very much longer than the arterial segment to be replaced was resected. It was then washed in Locke's solution, and deposited in a jar of vaseline.

2. *Temporary Hæmostasis, Section, and Resection of the Aorta.*—The abdominal aorta was dissected at the level of the genital arteries. The lumbar collateral branches were forcipressed or ligated. Between two Crile forceps, a long segment of aorta was isolated and a small part of it resected. As soon as the aorta was cut, the blood was washed out by an injection of Locke's solution. The vessel and the operative region were covered with vaseline, and isolated from the surrounding structures by black Japanese silk towels.

3. *Graft of the Vena Cava.*—The venous segment was removed from its jar, and interposed between the cut ends of the aorta, after the vaseline had been expressed from its lumen. The anastomoses were made by the ordinary method. Straight Kirby needles, No. 16, and fine silk threads, sterilized in vaseline, were used. The ends of the vessels were united by

three retaining stitches and a continuous through-and-through suture. As the diameter of the vena cava was larger than the diameter of the aorta, the calibre of the vena cava was progressively reduced. This could be done easily by leaving a larger distance between the stitches on the vein than on the artery. In order to secure an accurate approximation of the internal surfaces and a narrow scar, the edge of the vein was slightly eversed, the stitches were as loose as possible, and great care was taken not to include any connective tissue in the line of suture.

4. *Re-establishment of the Circulation.*—The Crile forceps placed on the lower end of the aorta was removed, and the blood entered the grafted segment. The sutures and the ligatures of the collateral branches of the vena cava were examined. The anastomoses were slightly compressed with dry gauze pads. The upper forceps were removed and the circulation re-established. After an arteriovenous anastomosis, the lines of sutures leak more or less for a few minutes, after which the hemorrhage stops spontaneously. If after two or three minutes there is still some hemorrhage, one or two stitches are added. The operation must not be ended before it is certain that not a drop of blood is oozing from the lines of suture. When the condition of the circulation was normal, the operation was completed by suture of the lumbar peritoneum and the closing of the abdominal section by four or five planes of suture. The animals were dressed and after a few hours allowed to walk and eat as usual.

Three experiments were performed on two cats and one dog.

*Experiment 1: Transplantation of a segment of vena cava between the cut ends of the abdominal aorta.*

Large yellow male cat. July 10, 1907. Dissection of the vena cava below the renal arteries. A segment three centimetres long is extirpated. Resection of the right kidney. Dissection and section of the aorta a few centimetres below the renal arteries. Graft between the ends of the segment of vena cava. July 15: Cat in normal condition. Normal pulsations of the femoral arteries. October 1: Cat in excellent health. No change in the femoral pulse. April 15, 1908: Femoral pulse normal. Cat slightly ill. April 25: Cat is sick. Femoral pulse normal. May 1, 1908: Pulse has disappeared. Animal walks normally. May 8: The animal is very sick. No femoral pulse. Killed by chloroform.

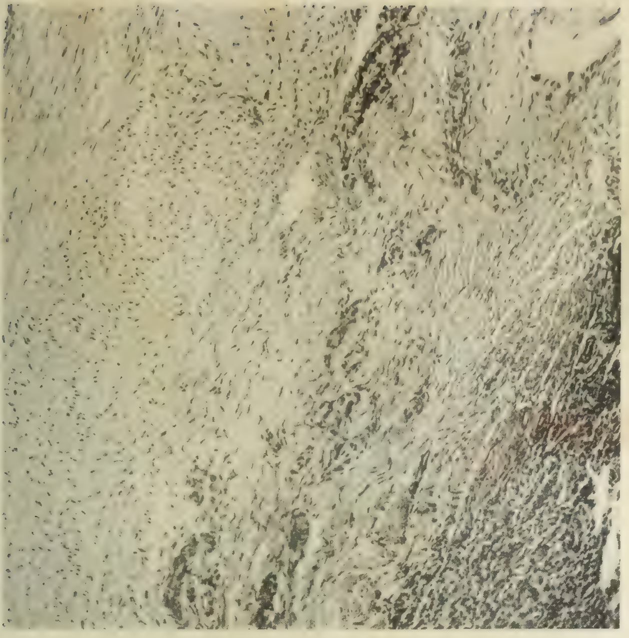
*Autopsy.*—Pyelonephritis, with perinephritic abscess. Obliteration of the transplanted segment by a clot of recent formation which is adherent to the wall. The aorta above and below the transplanted segment is normal. The calibre of the segment is almost the same as it was at the time of the operation. There is no sclerosis of the surrounding connective tissue. The venous wall is about the same thickness as the aortic wall. The internal surface of the lower part of the transplanted segment is smooth and glistening. On the upper part it is covered by a red clot, which is adherent to the wall at about one centimetre below the upper anastomosis. Both anastomoses are in perfect condition, smooth and glistening, and almost invisible. *Histological Examination.*—A small piece of the wall is cut at the level of the lower anastomosis. Section 97. Hæmatoxylin eosin and Weigert's elastic tissue stain. Longitudinal section of the vessel, showing the lower anastomosis and the adjoining parts of the aorta and vena cava. The wall of the vena cava is a little thicker than the wall of the aorta. The aortic wall is normal. Venous wall is composed of connective tissue with a few elongated cells. There are apparently no muscular cells. The union of the vena cava and of the aorta is very smooth. The aortic wall is slightly everted outward at the point of union. Very few elastic fibres in the venous wall, which is almost entirely composed of connective tissue.

*Experiment 2: Resection of a small segment of the aorta of a cat. Graft of a segment of vena cava.*

Large white male cat, very old. March 24, 1909, 10 A.M. Extirpation of a segment of vena cava of about 35 millimetres, just below the renal vein. Resection of a short segment of aorta at the level of the spermatic arteries. Graft of the vena cava between the cut ends. 3 P.M.: Animal walks about its cage. April 20: Femoral pulse normal. Animal is very fat and in good health. May 20: Animal is sick. Femoral pulse normal. May 25: Animal died.

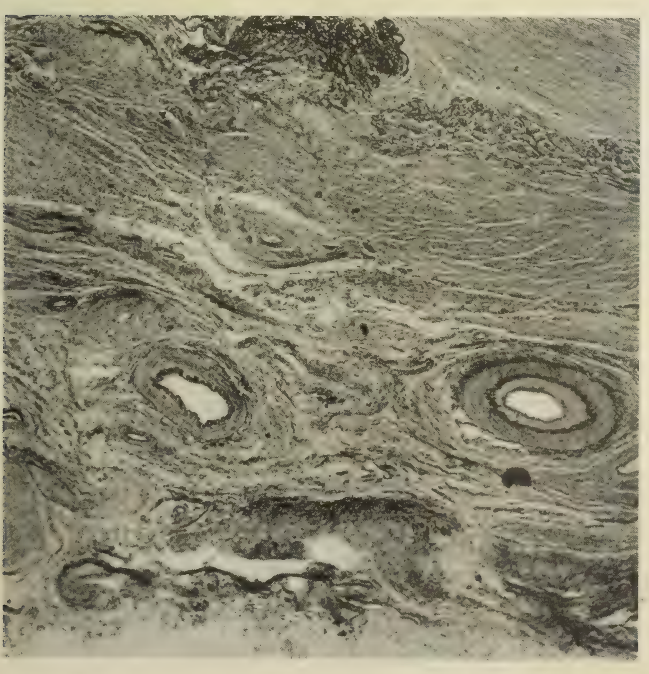
*Autopsy.*—Sclerosis of the kidneys. Fatty degeneration of the liver. *Macroscopical Examination.*—The transplanted segment is 34 millimetres long. Its calibre is larger than the calibre of the aorta. It does not seem more dilated than at the time of the operation. The walls of the aorta and vena cava are about of the same thickness. The internal surface is glistening, and slightly irregular. The anastomoses are excellent, without dilatation or stenosis. *Microscopical Examination.*—Hæmatoxylin eosin and Weigert elastic tissue stain. On a cross section of the transplanted segment, at about its middle part, the wall is composed of two parts—external and internal. The external coat is a very thick and well-vascularized adventitia; the internal part is composed of the media and of the intima. The media consists chiefly of very dense connective tissue and of elongated cell nuclei. Longitudinal section of the upper anastomoses shows the media of the aorta slightly bent outward and in perfect union with the vein (Fig. 1). There are no elastic fibres in the venous wall (Fig. 2).

Fig. 1.



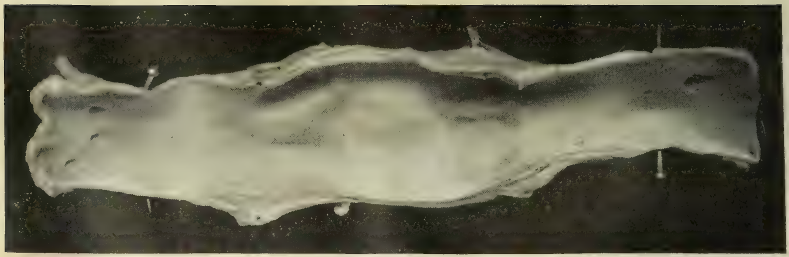
Longitudinal section of the upper arteriovenous anastomosis. Experiment 2.

Fig. 2.



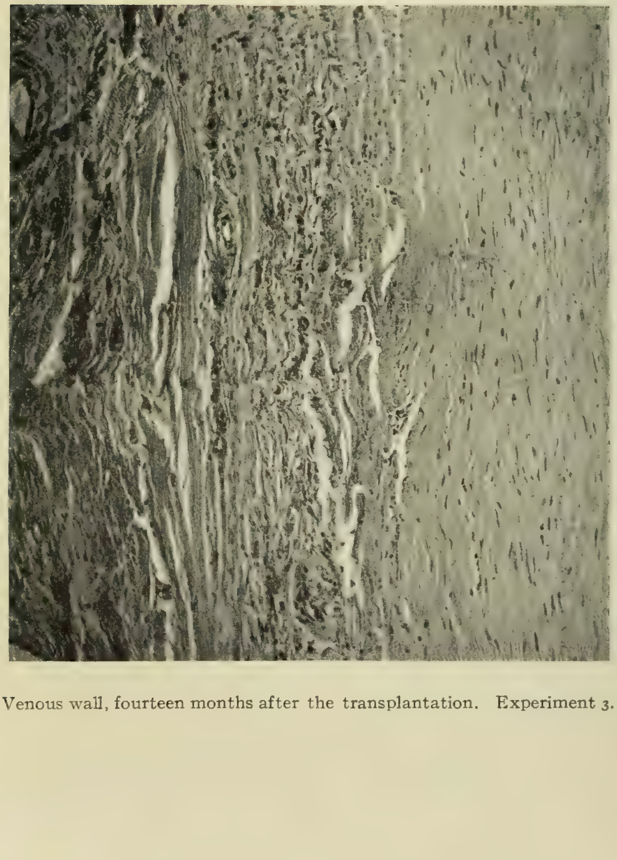
Same section stained by Weigert method.

FIG. 3.



Segment of vena cava transplanted on the abdominal aorta. Experiment 3. Fourteen months after the operation.

FIG. 4.



Venous wall, fourteen months after the transplantation. Experiment 3.

*Experiment 3: Resection of a segment of the abdominal aorta patched with peritoneum. Graft of a segment of vena cava.*

Middle-sized white bitch. November 24, 1908. Dissection of the abdominal aorta, a piece of which had been resected twenty-two months ago and replaced by a patch of peritoneum. Section of a segment of vena cava below the renal arteries. Resection of the patched segment of the aorta. Graft of the vein between the cut ends of the aorta.

November 25, 1908: Animal in good condition. Her hind legs are swollen. December 5, 1908: Œdema has disappeared almost completely. Animal in excellent condition. July, 1909: Animal normal. Normal femoral pulse. January 13, 1910: Animal died at the farm after an illness of a few days.

*Autopsy.*—Double pneumonia. Dissection of the aorta and of the venous segment which is 36 millimetres long. Its calibre has not markedly increased. The wall is very much thicker and a little transparent. The internal surface of both vessels is perfectly smooth and glistening, and anastomoses are excellent (Fig. 3). *Microscopical Examination.*—Intima a little thickened. The interstitial connective tissue has very much increased. The muscle-fibres are normal and seem to be increased in number. Very marked thickening of the adventitia (Fig. 4).

III. Results.—The three animals which underwent the transplantation of the vena cava on the abdominal aorta were in normal condition a few hours after the operation and recovered without any complication. In Experiment 3, the posterior limbs of the dog became swollen on account of the ligature of the vena cava but, after a short time, the œdema disappeared completely. No modification of the femoral pulse was observed. The causes, which after several months brought about, directly or indirectly, the death of the animals are completely independent of the operations. In Experiment 1, the cat was chloroformed ten months after the operation because he had developed pyelonephritis. The cat of Experiment 2 was very old. Three months after the operation, he became sick and died. The autopsy showed fatty degeneration of the liver and sclerosis of both kidneys. The dog of Experiment 3 lived in perfect health for fourteen months and then died of pneumonia in a few days.

Therefore, three months, ten months, and fourteen months after the operation the abdominal aorta of the animals and its venous segment were extirpated for the study of the anastomosis and of the venous wall.

Before longitudinal opening of the vessel the anastomoses could not be precisely located. There was no hardening of the wall at their level. The surrounding connective tissue was not sclerosed. In Experiment 1, the segment was occluded by a clot of recent formation. But, both anastomoses were normal. Their lumen was free. The scar was indistinct. The exact location of the anastomosis was determined by the difference in color between the venous and the aortic walls. In Experiment 2, there was a linear scar. In Experiment 3, the scar was also very narrow and almost invisible (Fig. 3). But the location of the anastomoses was easily detected because the aortic wall assumed a white color while the venous wall was slightly bluish. The union between the ends of the aorta and the segment of vena cava was very intimate. The media of the aorta bent slightly outward and ended abruptly. On its internal surface, the intima increased progressively in thickness, the artery united itself to the vein without interposition of scar tissue. The histological appearance of the anastomoses after the operation shows that the results are definitive (Figs. 1 and 2). The secondary occlusions observed by Frouin are certainly the result of a fault of technic. When an arteriovenous anastomosis is made by a proper method, no modification of its lumen can occur even after a long time.

The venous segment underwent a slight increase of its calibre and a very marked thickening of its wall (Fig. 3). In every experiment its diameter appeared to be slightly enlarged. The changes of the wall were very marked. In Experiment 1, the venous segment was occluded by a clot of recent formation, which developed after the occurrence of pyelonephritis. Above and below the thrombus, the venous wall was smooth and glistening. In Experiments 2 and 3, the internal surface of the wall was perfectly smooth. There was a slight difference in color between the aortic and venous walls. The wall of the vena cava was a little thicker than the arterial wall. It had lost all elasticity, and did not contract when the circulation was stopped. It was composed in Experiments 1 and 2 of dense connective tissue, the adventitia and the media being very much increased. Development of new elastic fibres was not observed (Fig. 2). In Experiment 1, the muscle-fibre nuclei disappeared. In Experiment 3, the muscle-fibres were found normal (Fig. 4). The thickening of the wall was due chiefly to a very marked sclerosis of the adventitia and of the media. It seemed that the number of the muscle-fibres had increased.

The adaptive changes of the vein begin immediately after its grafting on the artery. The wall thickens. There is, at first, an increase in the connective tissue, and probably also an increase in the number of the muscular fibres. Stich has observed the development of new elastic fibres. I observed it also in a few cases. But often, as it is shown in Experiments 1 and 2, there is no production of new elastic fibres. The elastic framework of the aorta stops abruptly at the point of anastomosis, and the venous wall is seen completely lacking in elastic tissue (Fig. 2). It seems that the first changes undergone by the vein can be compared to hypermyotrophy observed by Russell[14] in the first stage of certain forms of arteriosclerosis. It is a functional hypertrophy due to the increase of blood-pressure. It is not due to a change of nutrition produced by the arterial blood, because I found changes of the same nature in arteries in which the pressure was slightly raised, without any modification of the blood.

It is then certain that the first result of the increase of blood-pressure is an hypertrophy of the wall as it was shown long ago by Adami.[15] The vein has a tendency to become an artery. My experiments demonstrate that it can play perfectly its rôle. But it is possible that in some cases the wall undergoes a progressive sclerosis and that the muscle-fibres disappear completely after a few months. Four months after the transplantation of a segment of jugular on the carotid artery, I extirpated a small part of the wall and sutured the opening. The wall was very thick and composed of a sclerosed media containing normal muscle-fibres and of a greatly hypertrophied adventitia. Twenty months after the operation, the wall was examined again and modified. Sclerosis had increased and all the muscle had disappeared. This change did not interfere at all with the functions of the vena segment. Many experiments have shown that the presence of muscular or elastic fibres is not necessary to the normal function of an artery. However, sclerosis of the wall may lead to atheromatous changes, although it has not yet been observed. But it will be necessary to keep under observation animals with veins transplanted on arteries for eight or ten years in order to be sure that these degenerative changes do not occur. The knowledge of the remote results of these operations will decide whether fresh veins or arteries, fresh or preserved in cold storage, must be selected as grafts.

IV. Conclusions.—The transplantation of the vena cava on the aorta is not a dangerous operation. The three animals operated on recovered without incident.

The venous wall reacts against the arterial blood-pressure by thickening its wall.

The condition of the venous wall and of the anastomoses examined fourteen months after the operation shows that, for a long time, a segment of vena cava can functionate as a part of the abdominal aorta.

It is probable that in the treatment of aneurism, rupture of large arteries, embolus, and localized arteritis, the transplantation of venous segments can be used safely, but it must be emphasized that without a proper technic, the results of the operation will be disastrous.

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# A SUGGESTION FOR THE TREATMENT OF AIR EMBOLISM.

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THE object of this paper is to present the results of a study of air embolism with especial reference to its treatment. In this study other observations were of necessity made, but as these are mainly corroborative of work that has already been published—especially the work of Senn and Hare—a very brief account of it will be given.

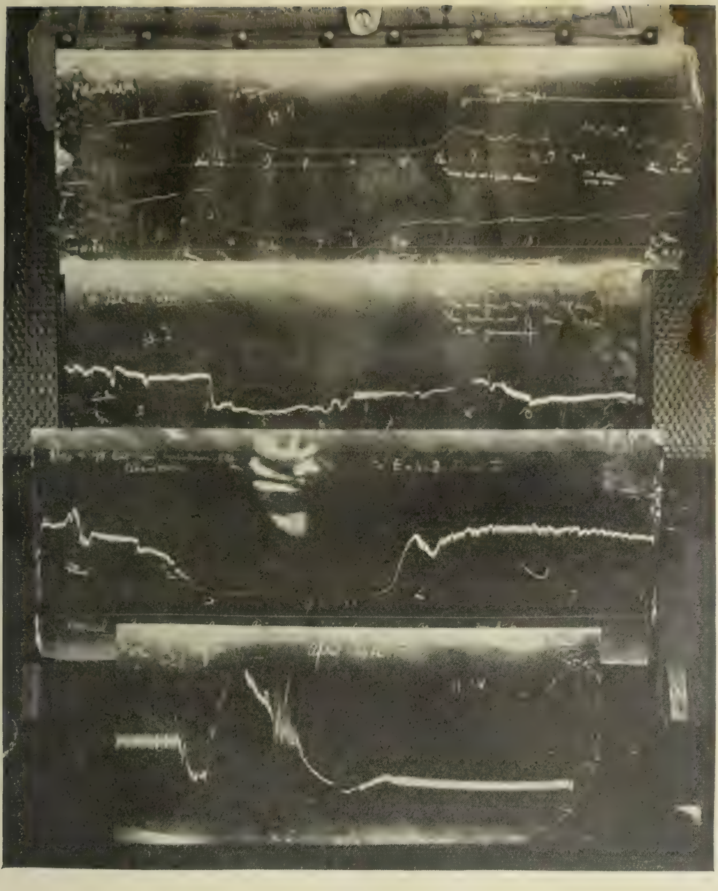
Senn, in 1885,[1] reported an extensive experimental and clinical study of air embolism. Wherever our work has been in common with his, we are entirely in agreement. Our motive in attacking the problem was different from his and our methods are different. Hare[2] reported an extensive research done on dogs, which is entirely in agreement with the results of Senn and was done without any knowledge of Senn's work. Goodridge[3] criticizes previous work but adds nothing new. Ezra Read Larned[4] gives results corresponding to those of Senn and Hare. In these four papers, especially those by Senn and Hare, a complete literature of air embolism is given.

When air in quantity suddenly enters the veins, it may be rapidly fatal (see Experiments 5 and 7, Figs. 2 and 3). The fatal dose varies enormously with the same and different species. (Compare Experiment 14, Drum 2, Fig. 6, points 2, 3 and 4 in which the dog received 90 c.c. of air in the jugular under pressure in four minutes, from which he recovered without treatment, also Experiment 21, Fig. 11, in which a dog aspirated about 175 c.c. air into the jugular in twenty-eight minutes with practically no serious effect, with Experiment 20, Fig. 10, in which a dog aspirated less than 15 c.c. of air in eleven minutes, which was almost immediately fatal.) As pointed out by Senn, Hare, Larned and others, in almost all animals the fatal dose is very much larger than is generally believed. The causes of death we have found are: (1) cardiac insufficiency due to a mechanical and to a vital cause; (2) respiratory failure.

When the air enters the right ventricle the auriculoventricular valve of that side does not close, and the light elastic air in the venæ cavæ allows regurgitation from the auricle. In the form of a coarse froth the air is churned backwards and forwards in the venæ cavæ with each contraction. This backward and forward motion of the air in large bubbles could be seen in the glass cannula in the jugular vein (see under method). The heart's effort is also apparently lessened. (See Experiment 11, B, Fig. 5, which shows a tracing of the excursion of the ventricular wall.) It will be seen that after each injection of 4 c.c. of air the contraction of the heart is considerably disturbed and is for a time less efficient. This may be due to lack of the stimulus of blood in the cavities. As a result of these two factors combined, little or no blood reaches the left ventricle, and the whole circulation including the coronary is stagnated, with consequent bulbar anæmia, causing respiratory failure, and cardiac anæmia, causing a real weakness and deterioration of the heart muscle. The possible influence of inhibitory impulses reaching the heart through the vagus is a subject that is reserved for further investigation.

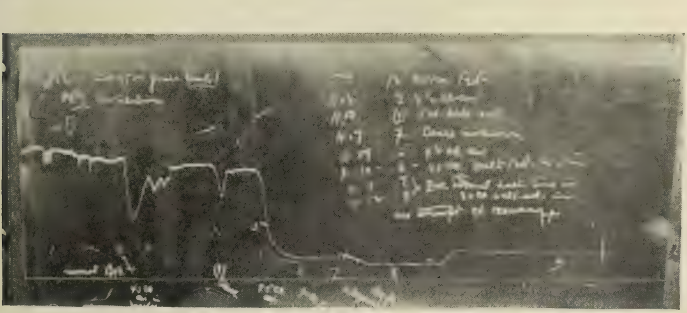
It has been disputed whether cardiac or respiratory failure is the primary cause. In every case we found that the respiration stopped first, and if artificial respiration was carried out effectively, the heart in some cases would again resume normal function. While the respiration first fails and the heart continues to beat, yet the respiratory failure is dependent on the heart. Though the heart continues to beat, it throws out very

Fig. 1



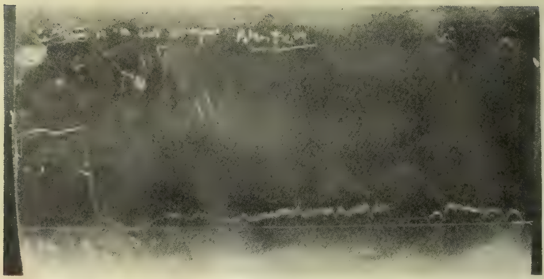
Experiment 4: Dog revived of itself. Experiment 1: Cat revived with .9 saline. Experiment 3: Cat which failed to revive with .9 saline was revived with .9 saline and adrenalin. Experiment 14, Drum 3: Dog revived with adrenalin in a concentrated solution.

Fig. 2.



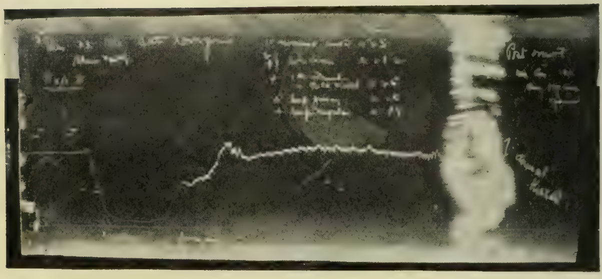
Experiment 5.

FIG. 3.



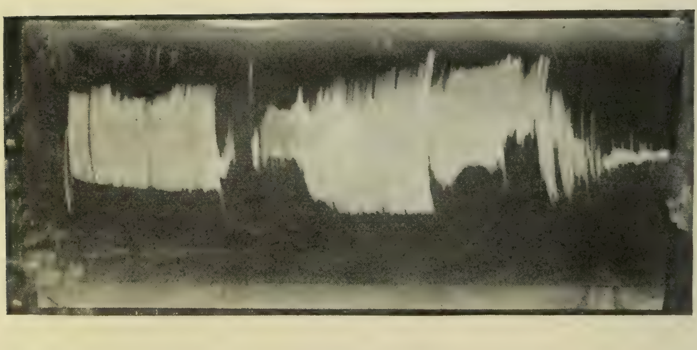
Experiment 7.

FIG. 4.

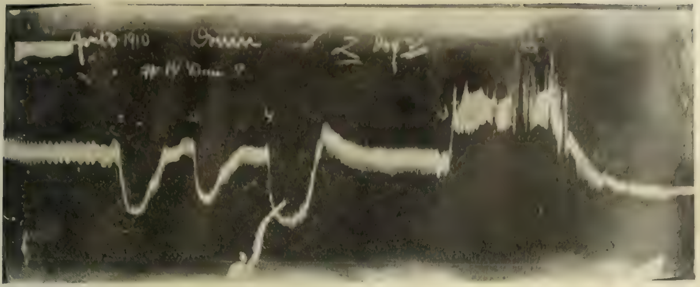


Experiment 8.

FIG. 5.

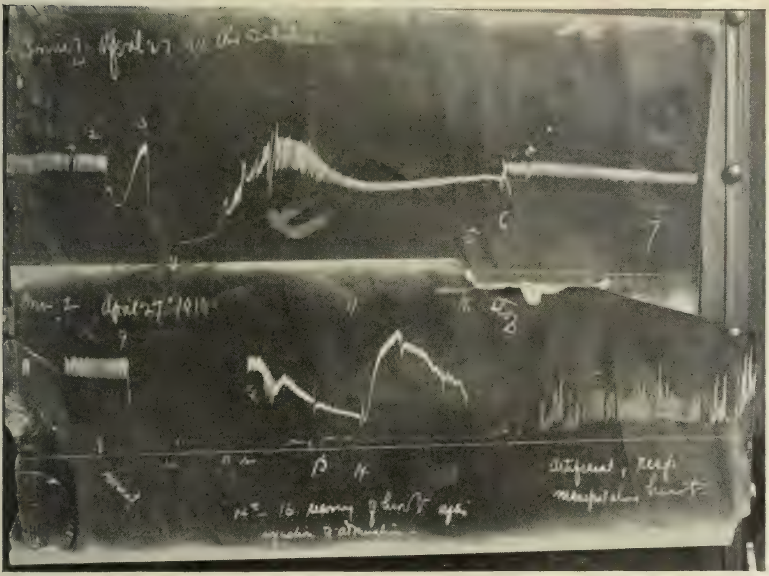


Experiment 11B.



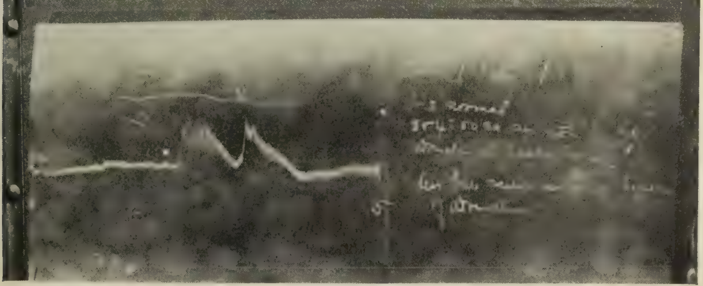
Experiment 14, Drum 2.

FIG. 7.



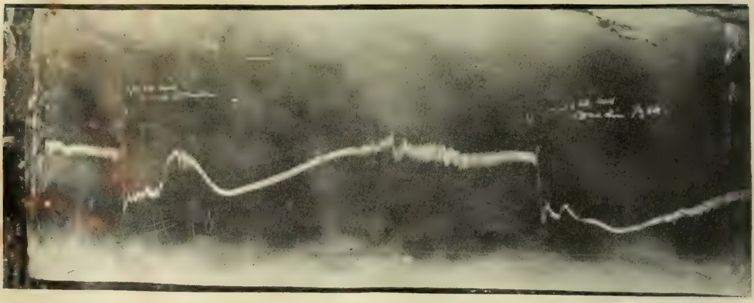
Experiment 15.

FIG. 8.



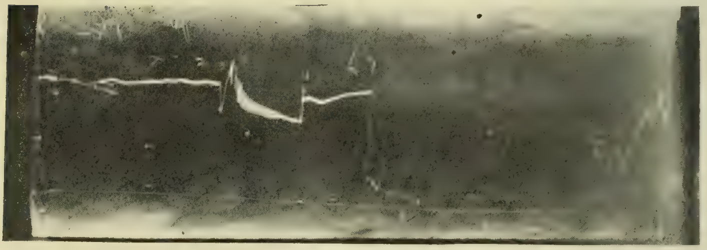
Experiment 17.

FIG. 9.



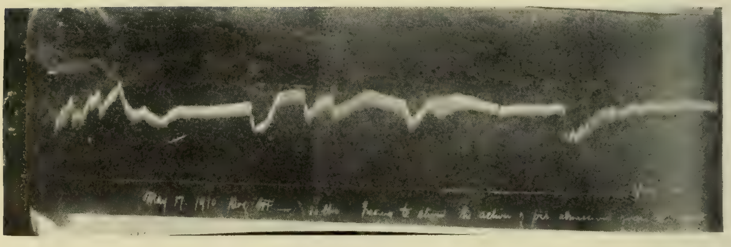
Experiment 18.

FIG. 10.



Experiment 20.

FIG. 11.



Experiment 21.

little blood, and because of this respiration stops from lack of nutrition of the respiratory centre.

The treatment that has so far been proposed has been both direct and indirect. It may be stated under the following headings: (1) the prevention of the admission of air by compression or ligation or both; (2) venesection; (3) cardiac stimulants; (4) direct aspiration of the heart and infusion of saline solution; (5) catheterization and aspiration of the right auricle to remove air and spumous blood and to relieve overdistention.

No doubt the proper use of any of these methods is of value. Some, however, are extremely heroic and others, apparently without danger, we have found to be decidedly detrimental. Many cases of air embolism, if left alone and untreated, will recover (see Experiment 4, Fig. 1). It must be an accident of very rare clinical occurrence but if it does occur, treatment to be effective must, in most cases, be quickly applied. The call for a comparatively conservative method, one that will be beneficial in all cases and detrimental in none, is quite obvious. It was the desire for such a method that prompted the present research.

Our first experiment in the line of treatment was to open the chest wall and attempt to re-establish the circulation by cardiac massage. This was proved futile both by the death of the animal and the failure to remove the air from the heart.

The next therapeutic attempt more nearly approached a clinical possibility, and was based on the theory that if the right heart could be but partially filled with fluid under pressure it would help to sweep the air into the pulmonary circulation, and the impact of the fluid against the valve cusps would cause them to close in the normal manner. We had observed that once the circulation was re-established, the vicious circle was broken, and that large quantities of air would be disposed of without causing serious embarrassment.

As an adjunct to flushing the right heart, it seemed to us that if an artery on the systemic circulation were opened, it would have the double effect of lessening the starting load and of partially compensating for the quantity of salt solution that we proposed to throw into the right heart. Though we did succeed in at least hastening the recovery of one animal (Experiment 1, Fig. 1) by this method, it did not work out as we had hoped. In most cases it failed and it proved more apt to cause paralysis of the heart than restoration of function. While we were carrying on this work, L. von Lesser [5] reported the simple infusion of saline as valuable; Von Lesser used 0.5 per cent. NaCl solution. We found no sufficient merit in the method. Not only does the method of simple saline infusion seem to have little to recommend it in any case, but it is decidedly dangerous. The heart is already weak and tends to dilate. When salt solution is injected quickly and in volumes sufficient to help sweep the air out of the heart, it almost invariably causes a dilatation that is harmful, often fatal. In several experiments, in running the saline into the vein at 90 cm. of water pressure, the heart suddenly ceased beating and on opening the chest no beat could be observed, but on simply opening the pericardium an ineffective beat was resumed. If the saline solution be injected slowly, it is of no value, although Goodridge advises injection into the median basilic vein in conjunction with direct aspiration of the heart with a fine trocar.

From what we observed while working on this method, it seemed that the fault lay in the fact that the heart would not respond to the extra load, and that if some powerful instantaneous cardiac stimulant could be brought to bear this fault might be overcome. The addition of adrenalin chloride to the salt solution proved decidedly advantageous, greatly increasing the percentage of recoveries. This is demonstrated by Experiment 3, Fig. 1, where salt solution and artificial respiration failed, but prompt recovery occurred on flushing with 50 c.c. of 0.9 saline containing 1 c.c. of a 1 : 1000 adrenalin chloride solution, and Experiment 8, Fig. 4, where recovery followed the use of 1 c.c. adrenalin chloride solution in 90 c.c. of 0.9 saline solution. Adrenalin in this dilution did not, however, entirely eliminate the danger of cardiac paralysis where large quantities of fluid were rushed to the heart (see Experiment 7, Figs. 3, 9 and 13).

### EXPERIMENT 1, MARCH 10, 1910.

*Cat, Weight 3000 Grammes.*

| Time | | Blood-pressure Hg. |
|---|---|---|
| 12.15: | Normal blood-pressure | 92 mm. |
| 12.15: | 1 c.c. air, blood-pressure immediately | 74 mm. |
| 12.18: | Blood-pressure | 84 mm. |
| 12.20: | 3 c.c. air in jugular | 52 mm. |
| 12.22: | | 28 mm. |
| 12.22: | 100 c.c. normal salt sol. in jugular | |
| 12.27: | Blood-pressure | 60 mm. |
| 12.38: | Blood-pressure | 88 mm. |
| 1.00: | Cat, normal, killed. | |
| | Autopsy: no air could be found in any of the organs. | |

### EXPERIMENT 2, MARCH, 1910.

A number of experiments were made that are not recorded here. In most instances the injection of air, saline, or adrenalin, and the resulting blood-pressure are recorded as being synchronous, but in reality the blood-pressure reading was made a fraction of a minute later than the injection.

*Cat, Weight 4100 Grammes.*

| Time | | Blood-pressure Hg. |
|---|---|---|
| 11.45: | Normal blood-pressure | 180 mm. |
| 11.46: | 3 c.c. air in jugular | 140 mm. |
| 11.46½: | | 184 mm. |
| 11.47: | 4 c.c. air | 108 mm. |
| 11.49: | | 170 mm. |
| 11.50: | 4 c.c. air | 98 mm. |
| 11.51: | 4 c.c. air | 70 mm. |
| 11.52: | | 110 mm. |
| 11.52½: | 4 c.c. air | 50 mm. |
| 11.54: | | 28 mm. |
| | Commenced to run in salt solution at a pressure of 90 cm. water—no recovery. | |

### EXPERIMENT 3, MARCH 9, 1910.

*Cat, Weight 2500 Grammes.*

| Time | | Blood-pressure Hg. |
|---|---|---|
| 12.07 : | Blood-pressure | 120 mm. |
| 12.08.5: | 4 c.c. air in jugular | 42 mm. |
| 12.09.5: | Commenced to run in salt solution in jugular—100 c.c. run in. | |
| 12.11 : | Artificial respiration. | |

| Time | | Blood-pressure Hg. |
|---|---|---|
| 11.49 | | 170 mm. |
| 12.12 | No heart-beat felt—respiration very slow, blood-pressure. | 30 mm. |
| 12.12 | Adrenalin 1 c.c. in 100 c.c. saline ran into jugular. | |
| 12.14 | Blood-pressure | 130 mm. |
| 12.15 | 47 c.c. blood drawn from femoral. | |
| 12.17 | Respiration jerky but becoming normal. | |
| 12.43 | Animal in good condition, blood-pressure | 120 mm. |

In this case after salt solution had failed, the animal was in very poor condition; adrenalin caused a complete recovery.

*Postmortem.*—The heart was normal, no air could be found in any of the organs.

## EXPERIMENT 4, MARCH 12, 1910.

*Cat, Weight 1500 Grammes.*

| Time | | Blood-pressure Hg. |
|---|---|---|
| 10.00 | Normal blood-pressure | 108 mm. |
| 10.03 | 3 c.c. air in jugular, pressure falls to | 68 mm. |
| 10.07 | Blood-clots in cannula | 92 mm. |
| 10.08 | 4.5 c.c. air in jugular | 20 mm. |
| 10.09 | Respiration very slow and deep and at, | |
| 10.09.5 | Respiration practically ceased, heart impulse can still be seen, blood-pressure | 22 mm. |
| 10.10.5 | Great dyspnœa, blood dark and clots readily, blood-pressure | 28 mm. |
| 10.12 | Respiration and heart improved | 32 mm. |
| 10.18 | Respirations 3 per minute | 42 mm. |
| 10.30 | Respiration regular, 14 per minute | 84 mm. |
| | The animal here normal so far as can be judged. | |
| 10.31 | 4.5 c.c. more air in jugular and pressure falls quickly to 22 mm. | |
| 10.40 | No respirations in 2 minutes and heart-beat scarcely perceptible. | |
| 10.41 | Artificial respirations commenced and 0.5 c.c. adrenalin in 60 c.c. salt solution injected into jugular. But treatment apparently without result. Heart-beat revived but continuous cardiac massage necessary, and heart stops on withdrawing the treatment. | |

*Postmortem.*—11.00: Air was found in both sides of the heart and in the coronary veins. When the heart was removed from the body it still beat but not effectively. More prolonged treatment might have been effective.

*Results.*—This small animal recovered completely from a large volume of air without treatment. As a smaller volume has killed a larger animal, this fact makes it difficult to place a true estimate on treatment, as the animal, if left alone, recovers in many cases.

### EXPERIMENT 5, MARCH 16, 1910.

*Cat, Weight 3500 Grammes (Male).*

| Time | | Blood-pressure Hg. |
|---|---|---|
| 10.03: | Normal pressure | 164 mm. |
| 10.05: | 4.5 c.c. air in jugular | 80 mm. |
| 10.07: | | 150 mm. |
| 10.09: | 4.5 c.c. air in jugular | 30 mm. |
| 11.12: | 40 c.c. salt solution<br>Containing 1 c.c. adrenalin, this was repeated in 1 minute —no sign of recovery. | 20 mm. |
| 11.20: | Animal dead. | |

*Postmortem.*—Clot in right heart. Air in right heart, lungs, and inferior vena cava back to liver, no air in left heart.

### EXPERIMENT 6, MARCH 19, 1910.

*Cat, Weight 1600 Grammes.*

| Time | | Blood-pressure Hg. |
|---|---|---|
| 10.40: | Normal pressure | 128 mm. |
| 10.41: | 4.5 c.c. air in jugular<br>Animal died immediately, adrenalin in salt solution; bleeding gave no signs of recovery. | 4 mm. |

### EXPERIMENT 7, MARCH 16, 1910.

*Cat, Weight 2500 Grammes.*

Blood-pressure 134 mm. Was injected with 9 c.c. air—pressure fell at once to zero and treatment with adrenalin and salt was ineffective.

*Autopsy.*—Showed air in all abdominal veins, air in right heart, no air in left heart, not dilated.

### EXPERIMENT 8, MARCH 23, 1910.

*Cat, Weight 2000 Grammes.*

| Time | | Blood-pressure Hg. |
|---|---|---|
| 10.20–23: | Normal blood-pressure | 118 mm. |
| 10.23: | 6.5 c.c. air in jugular | 10 mm. |
| 10.25: | Respiration stopped, no heart-beat perceptible; 1 c.c. adrenalin in 90 c.c. salt solution and pressure immediately rises. | |
| 10.26: | Respiration jerky and becoming more frequent. | |
| 10.28: | Respiration labored but becoming more regular | 120 mm. |
| 10.30: | Animal normal in respiration and pressure | 120 mm. |
| 10.37: | Animal killed. | |

*Postmortem.*—No air found in any organs, all normal. In this case the adrenalin may have been the direct cause of recovery.

### EXPERIMENT 9, MARCH 25, 1910.

*Cat, Weight 2350 Grammes.*

| Time | | Blood-pressure Hg. |
|---|---|---|
| 11.15 | Normal pressure | 140 mm. |
| 11.16 | 9 c.c. air in jugular. | |
| 11.16.5 | Respiration stopped, heart still beating | 10 mm. |
| 11.17.5 | Respiration 1 per minute. | |
| 11.18.5 | Heart 180 per minute | 8 mm. |
| | Adrenalin salt solution and artificial respiration gave no sign of being beneficial. | |
| 11.30 | *Autopsy*—air in right and left heart and vena cava. After the removal of the air the heart commenced to beat. In this case after the adrenalin had been used without effect, aspiration might have been beneficial. | |

### EXPERIMENT 10, MARCH 26, 1910.

*Dog, Weight 6350 Grammes.*

| Time | | Blood-pressure Hg. |
|---|---|---|
| 11.14 | Normal pressure | 160 mm. |
| 11.15 | 9 c.c. air in jugular | 140 mm. |
| 11.15¾ | Respiration labored, pressure | 160 mm. |
| 11.18.5–11.19.5 | 35 c.c. air injected | 68 mm. |
| 11.20 | | 164 mm. |
| 11.35 | Animal normal, pressure | 160 mm. |
| 11.38.5 | 50 c.c. air injected | 50 mm. |
| 11.40 | | 160 mm. |
| 11.45 | 170 c.c. air injected | 20 mm. |
| 11.46 | Respiration stopped, heart weak, injection of salt solution 100 c.c. 0.9 and adrenalin in 1 c.c. caused a slight improvement. | |
| 11.48 | Dog gasping | 40 mm. |
| | 100 c.c. more salt solution containing 1 c.c. adrenalin and artificial respiration gave no further improvement. | |
| 11.50 | Animal dead. | |

*Autopsy.*—Air in all chambers of heart and abdominal vessels.

### EXPERIMENT 11, APRIL 12, 1910.

100 c.c. air killed a 20 lb. dog and all treatment was useless. Death immediately, heart dilated and air in both sides.

11A. 50 c.c. killed a 17 lb. dog immediately; by the injection of 300 c.c. salt solution in jugular, bleeding from the carotid, we were able to wash some of the air out of the heart, but this treatment was ineffective. The heart continued to beat weakly after respiration ceased.

11B. Shows a myocardiogram of cat during repeated injections of 4 c.c. air.

Experiment 12 similar to 11.

## EXPERIMENT 13, APRIL 20, 1910.

*Dog, Weight 24 Pounds.*

| Time | | Blood-pressure Hg. |
|---|---|---|
| 11.35 | Normal blood-pressure | 124 mm. |
| 11.40 | 40 c.c. air in jugular | 78 mm. |
| 11.41 | | 140 mm. |
| 11.46 | 50 c.c. air | 28 mm. |
| 11.46.5 | | 28 mm. |
| 11.48 | Respiration stopped; 1 c.c. adrenalin in 100 c.c. salt solution ran in at 50 cm. water pressure gives no improvement. | |
| 11.49.5 | Heart flickering, artificial respiration does no good. | |

*Autopsy.*—A little air in abdominal veins. None in the small veins. Air in right ventricle and pulmonary arteries but none in left ventricle.

## EXPERIMENT 14, APRIL 20, 1910.

*Dog.*

| Time | | Blood-pressure Hg. |
|---|---|---|
| 12.36 | Normal pressure | 140 mm. |
| 12.39 | 35 c.c. air in jugular, respiration becomes very rapid and pressure falls to | 62 mm. |
| 12.40.5 | Pressure | 144 mm. |
| 12.41 | 25 c.c. air injected, hyperpnœa and pressure falls to | 80 mm. |
| 12.43 | Pressure | 140 mm. |
| | 30 c.c. air injected, respiration resembles vomiting movements and pressure falls to | 54 mm. |
| 12.46 | Pressure | 150 mm. |
| 12.48 | 1 c.c. adrenalin in 4 c.c. saline injected—typical adrenalin action. | |
| 12.52 | Pressure | 100 mm. |
| 12.53 | Stopped to clean out clot. | |
| 1.01.5 | Normal pressure | 130 mm. |
| 1.02 | 40 c.c. air in jugular, pressure falls to | 75 mm. |
| 1.03.5 | Respiration stopped, pressure | 76 mm. |
| | 1 c.c. adrenalin solution injected gives typical adrenalin rise. | |
| 1.04 | 75 c.c. blood taken from femoral. | |
| 1.07 | | 58 mm. |
| 1.08 | 230 c.c. salt solution injected at a pressure of 30 cm. water. | |
| 1.15 | Steady for 5 minutes at | 80 mm. |
| | Experiment stopped and animal killed. | |

*Autopsy.*—No air found in heart, lungs, or large veins, or coronary arteries. Organs apparently normal.

*Results.*—Adrenalin quickly restored animal after respiration had ceased, but while pressure was still high. Unquestionably the animal would have recovered without treatment, but recovery was much quicker with it. Bleeding relieves the pressure and allows the adrenalin to act on the heart without the probability of danger from high blood-pressure. A remarkable feature was the complete absorption of 130 c.c. of air in 40 minutes or less.

## EXPERIMENT 15, APRIL 27, 1910.

*Dog, Weight 28 Pounds.*

Time — Blood-pressure Hg.
11.05: Blood-pressure ........................................ 124 mm.
11.05.5: 50 c.c. air in jugular.
11.06: Pressure ........................................ 70 mm.
11.07: Pressure ........................................ 140 mm.
50 c.c. air injected.
11.08: Respiration stopped, heart very weak, pressure.......... 28 mm.
1 c.c. adrenalin in 80 c.c. salt solution at 45 cm. water pressure. Immediate good effect.
11.09: Pressure rising rapidly and respiration improving.
11.10: Blood-pressure ........................................ 140 mm.
11.15: Blood clotting ........................................ 110 mm.
11.25: Respiration normal, blood-pressure ..................... 138 mm.
The treatment here is unquestionably effective.
11.30: Blood-pressure ........................................ 120 mm.
11.30.5: 90 c.c. air injected.
11.31: Respiration stopped, heart very weak, blood-pressure.... 16 mm.
Adrenalin, artificial respiration, vagi cut and salt solution—could not restore animal.
11.50: Chest opened and direct massage of the heart restored beat.
11.52: Heart revived and in good condition.
11.58: Experiment stopped.

*Postmortem.*—Air in the vena cava and right heart, none in left heart.

*Results.*—Adrenalin was decidedly beneficial in this case. This is especially the case when the heart is almost able to overcome the obstruction without help. When the blood-pressure falls to almost zero and quickly it is of less value. When a very large volume of air is injected adrenalin fails.

## EXPERIMENT 16, APRIL 28, 1910.

*Dog, Weight 25 Pounds.*

Time — Blood-pressure Hg.
11.17: Normal blood-pressure ........................................ 164 mm.
11.18: 100 c.c. air in jugular, pressure immediately falls, and at
11.20: ........................................ 18 mm.

Adrenalin and salt solution was ineffective. The animal died without the faintest appearance of recovery. This amount of air forced into the heart makes it impossible to force in salt solution and adrenalin. In fact, if the cannula is open, much of the air would pass out through the same veins that it entered. Such an amount of air could but slowly enter the heart at normal pressure.

## EXPERIMENT 17.

### *Dog, Weight 16 Pounds.*

This experiment was made to demonstrate the antagonistic effects of air and adrenalin on the heart.

| Time | | Blood-pressure Hg. |
|---|---|---|
| 11.38: | Normal blood-pressure | 130 mm. |
| 11.43: | Normal blood-pressure | 130 mm. |
| 11.43: | 50 c.c. air used to force in adrenalin. There was no fall in this case. A small adrenalin rise which soon reached normal again. | |
| 11.46: | Blood-pressure | 132 mm. |
| | The above injection was repeated with like results. | |
| 11.48: | Blood-pressure | 130 mm. |

The air in this case, 100 c.c. in a small dog, caused no fall of pressure.

*Postmortem.*—Air in the pulmonary artery. Fine bubbles of air in right heart but none in left; heart beat strong for some time after removal from body.

## EXPERIMENT 18.

### *Dog, Weight 10 Pounds (Good Tracing).*

To show the influence of adrenalin injected immediately after air.

| Time | | Blood-pressure Hg. |
|---|---|---|
| 12.30: | Normal pressure | 128 mm. |
| 12.35: | 40 c.c. air followed immediately by 0.4 c.c. adrenalin. Pressure falls to | 50 mm. |
| | Immediately begins to rise. | |
| 12.36: | | 70 mm. |
| 12.39: | | 120 mm. |
| 12.45: | | 130 mm. |
| 12.45.5: | 50 c.c. air followed immediately by 0.4 c.c. adrenalin. Heart is strong in pressure and slow and gradual. | |
| 12.47: | | 70 mm. |
| 12.50: | | 40 mm. |
| | After this the rise was gradually higher. | |
| 12.52: | | 90 mm. |
| 1.00: | | 98 mm. |
| 1.00: | 85 c.c. air. | |
| 1.01: | Pressure falls to | 10 mm. |
| | And adrenalin, salt solution and artificial respiration failed to revive. | |

*Autopsy.*—Air in right heart and coronary veins, and abdominal veins. No air in left ventricle.

### EXPERIMENT 19, MAY 6, 1910.

*Dog, Weight 8 Pounds.*

30 c.c. air killed this animal immediately and adrenalin was without effect—administered 1 minute after the air.

### EXPERIMENT 20.

A dog, weight 9 pounds, with trachea clamped during the period of the first three respiratory efforts, and cannula in jugular connected with condom containing a measured amount of air. During 29 respirations the animal drew into the vein between 10 c.c. and 15 c.c. air, which killed it.

Adrenalin was without effect. The measuring apparatus was not perfectly satisfactory and the experiment was repeated. The imperfection here was lack of exactitude in the measurement of the air. The air was aspirated from an unstretched thin rubber bag and the possible error was within the limits named.

### EXPERIMENT 21.

Dog, weight 20 pounds; with a perfect apparatus the animal could not draw in enough air to kill it.

Our next method was to introduce into the heart a rather concentrated solution of adrenalin, using a relatively small quantity of normal saline solution to carry it from the jugular vein, where it was introduced. The essential difference between this and the preceding method is that reliance is placed chiefly upon a very concentrated solution of adrenalin reaching the heart chambers and causing violent contractions. The normal saline solution is used chiefly as a carrier and in quantity sufficiently small to insure its freedom from the danger of overdistention. The exact technic was to inject the quantity desired of the 1 : 1000 adrenalin chloride solution by means of a hypodermic into the rubber tube that leads to the cannula in the vein. By this means the adrenalin was concentrated in the first part of saline that entered the vein, the remaining saline being used to insure its reaching the heart. It is because of our apparently successful results with this drug that we report the work. Artificial respiration is often of value, whatever other treatment may be instituted.

### METHODS.

Cats and dogs were used. The animals were prepared for blood-pressure tracings. A cannula was inserted in the right external jugular close to its innominate junction, for the injection of air and adrenalin and salt solution. A continuous blood-pressure tracing was taken during the experiment, and is recorded in millimetres mercury. A measured volume of air was injected in each case. When the quantity was small, injection was made with an air-tight syringe; when over 10 c.c. it was pressed in by a syphon.

To simplify description, the general results obtained will be given, twenty-two of the series having been presented in tabular form.

Injection of air into the heart, no matter how small the quantity may be, produces a disturbance of the circulation that can readily be seen in the blood-pressure record; there are a fall of pressure, dyspnœic symptoms, and restlessness. If the volume of air injected be small, these changes are usually extremely temporary; if large, a sudden fall of pressure to almost the base line occurs, great dyspnœic and labored breathing, and a fluttering heart. The respiration always stops before the heart, but the ineffectiveness of the heart-beat is the cause of the respiratory failure. In other words the practically valveless right heart cannot supply blood to be pumped to the respiratory centre and the centre fails while the heart continues to beat ineffectively, the blood-pressure being almost zero. While the heart is in this condition, the injection of adrenalin is very effective in restoring the normal pressure in some cases; in others it is worthless; whether or not it is of value seemed to depend largely upon the character of the heart-beat at the time the injection was made and the length of time that had elapsed since respiration ceased. Except where air or fluid is rushed into the heart under considerable pressure, the heart-beat does not cease for some time, but the beat becomes less and less strong. Where at autopsy, after rushing air and fluid into the heart, no beat was seen, the beat always recurred on opening the heart and removing the internal pressure. In all cases where at postmortem air was found in quantity in the left heart, adrenalin was ineffective. The action of adrenalin can also be most clearly seen if it is injected with the air, or closely following (Experiments 17, Fig. 8, and 18, Fig. 9). In Experiment 17 the air was injected at low pressure and the adrenalin effect predominated. In 18 the air was injected suddenly at considerable pressure and then there is a fall of blood-pressure before the adrenalin "takes hold." As already shown, the result of air injection under apparently similar circumstances is so variable, that from a relatively small number of experiments, negative conclusions cannot be drawn, but this does not decrease the value of certain definite observations that were made, nor does it preclude using these positive observations as the bases of the certain positive conclusions. Besides the variable amounts of air that could be taken into the venous circulation close to the heart before lethal symptoms resulted, the most interesting observation was the rapidity with which large quantities of air were disposed of after the circulation was once established. Experiment 21, Fig. 11, was started at 11.20 and the heart was clamped at 12 A.M. During this time the dog had aspirated 175 c.c. air through the jugular vein. No air was found in the venæ cavæ; ⅓ c.c. air was obtained from the right ventricle and a minute bubble from the left. Under water in a bell-jar, no air could be washed from the pulmonary vessels, using water syphoned from a height of two metres. This rapid absorption or elimination of air was demonstrated in a number of experiments.

During these experiments we observed nothing that would verify the conclusions that the depression accompanying air embolism is due to blocking of the pulmonary vessels with air, but the rarity with which traces of air were found on the left side of the heart or were seen in the carotid cannula, even after large quantities of air, 100 c.c. or more, had been rapidly disposed of, leads us to the tentative conclusion that at least a part of the air was either eliminated or absorbed while passing through the pulmonary circulation. (See Experiment 14,—130 c.c. of air had entirely disappeared after 40 minutes.)

It was observed that with an open cannula in the proximal end of the jugular vein, air was aspirated into the vein with the first inspiration, but that almost immediately there was a back pressure from the leaking heart. If the cannula was left in the vein and the open end inserted into an undistended, thin rubber bag containing a measured quantity of air, it was found that air was aspirated interruptedly (see Experiment 21, Fig. 11).

Based on the observations made during these experiments, we believe that death from air embolism is clinically a rare occurrence, but should grave depression follow the aspiration of air into a vein, the treatment we propose is the introduction of adrenalin chloride in a fairly concentrated solution, 1 : 10,000 to 1 : 1000, directly into the right ventricle and that this be accompanied by a small amount of normal saline solution. In our experiments we always used 40 c.c. or more of saline solution, but in most cases a large quantity of air had been put in under pressure and it required a pressure of 60 cm. of water to force the fluid into the vein.

For clinical application a fine hypodermic needle could be pushed through the chest wall directly into the right heart, which could be done by inserting the needle through the chest wall and lung at the anterior extremity of the third or fourth right intercostal spaces. We observed no evil effects in dogs from perforating the heart wall with a fine needle, but to attempt to do it through the chest wall would be a very uncertain procedure.

Air embolism usually results from operations in the neck, in which large veins are exposed. We believe a practical application of this treatment would be to insert a douche point or transfusion needle attached to some sort of transfusion apparatus or douche can containing normal saline. The adrenalin chloride can be introduced into the tube of the douche apparatus close to the vein by piercing it with a hypodermic needle. The water can be put in with probable safety at a pressure of 25 to 30 cm. of water pressure.

In regard to the quantity of a 1 : 1000 adrenalin solution to be used, we would suggest that 2 c.c. be tried in a severe depression and repeated. In dogs, ¼ c.c. was sometimes effective, and the extreme activity resulting from a large dose was of but a short duration (Experiment 15, Fig. 7, and also 14, Drum 2, Fig. 6) and any dangerous symptoms short of apoplexy arising from an overdose can be modified by bleeding from an artery (Experiment 14, Drum 3, Fig. 1).

Artificial respiration according to the Schafer method should be employed when respiration ceases. As a last resort, the chest might be opened and direct cardiac massage applied (see Experiment 15, Fig. 7). We revived two dogs in this manner after giving the adrenalin. The experiments of Senn show that horses are more severely affected by air embolism in the erect than in the recumbent position, and we advise this position during the effort at resuscitation.

In animals in which the air was forced in under pressure, it was necessary in most cases to apply the remedy within two minutes, but it is probable in many clinical cases in which small quantities of air were aspirated that sufficient time will elapse between the accident and death to allow of some attempt to save them.

The violent contraction of the heart muscle that results from the introduction of a concentrated adrenalin chloride solution into its cavities, is the most efficient agent that we found for restoring a circulation embarrassed by air embolism (see Experiments 4, 1, 3, and 14, Drum 3, Fig. 1).

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# PRESERVATION OF THE SUBMAXILLARY BRANCH OF THE FACIAL NERVE IN OPERATIONS ON THE NECK.

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In considering the permanent results of the operative and non-operative treatment of tubercular cervical lymph-nodes, we must not lose sight of the scars and deformities occasioned by the disease or by surgical interference. Not least among these is paralysis of that branch of the facial nerve which supplies the depressor muscles of the lip. This branch, from its emergence from the parotid gland to its entrance into the depressor muscles, lies in intimate contact with the nodes most frequently involved in the tuberculous process, and is very often pressed on, cut, torn or crushed with a resulting more or less complete and permanent paralysis of the lower lip. This deformity is not inconsiderable, and its avoidance is worth serious attention.

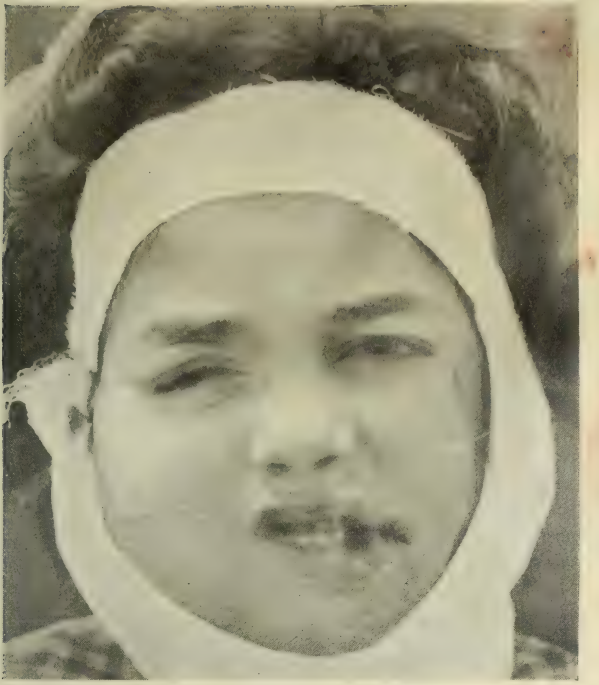
The descending or cervicofacial branch of the facial nerve divides between the lobes of the parotid gland into three main branches,—the transverse, which immediately pierces the mesenteric fascia and supplies the upper or facial portion of the platysma; the descending branch, which leads obliquely downward and forward to become superficial after piercing the deep fascia about the angle of the jaw and supplies the cervical portion of the platysma in conjunction with the superficial branches of the cervical plexus; and the submaxillary branch (collomandibularis of Jaffé), which remains beneath the superficial layer of the deep fascia during its entire course from the angle of the jaw and beneath the ramus, which it crosses with the facial vessels. The first two branches are of no practical importance, but this submaxillary portion supplies the depressor labii inferioris and the depressor anguli oris, and its injury results in a paralysis which is very noticeable in smiling, crying, etc. If the nerve is injured beyond repair the paralysis is permanent, as is proven by numerous experiences.

The statement is sometimes made that other branches of the facial or the cervical nerve will compensate for this loss, but this is as unreasonable as to expect a restoration of function in paralysis of the levator palpebræ or following permanent Bell's paralysis, or the paralysis of any given muscle with single nerve supply. Motor nerves are end nerves, so to speak, and do not take up the function of neighboring structures. It is probable that the occasional recoveries from this paralysis are due to a minor degree of trauma primarily, or perhaps to a union of the severed nerve when the ends are favorably placed.

To avoid injuring the nerve, incisions in front of the sternomastoid should always be transverse and at least three-quarters of an inch below the jaw. The deep fascia should be incised freely until the vessels and submaxillary salivary gland are exposed. The nerve clings tightly to the under surface of the superficial layer of the deep fascia, and is usually one-fourth to one-half inch below the jaw. It will be retracted with the upper flap and is safe except in the removal of the nodes above the salivary gland. Here the dissection must be blunt, from within upward and outward, and even with the greatest care the nerve will sometimes be injured. If so, the severed ends should be reunited at once.

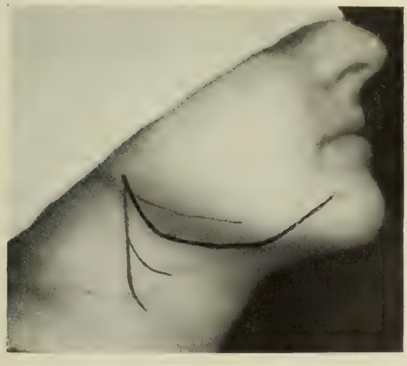
The illustrations show fairly well the relations of the nerve to the various structures in the neck, particularly the deep fascia. The author wishes to express his gratitude to Professor Haynes, under whose direction the dissections were made at the Cornell University Medical School, and to Doctor Charles N. Dowd for his advice and encouragement.

FIG. 1.



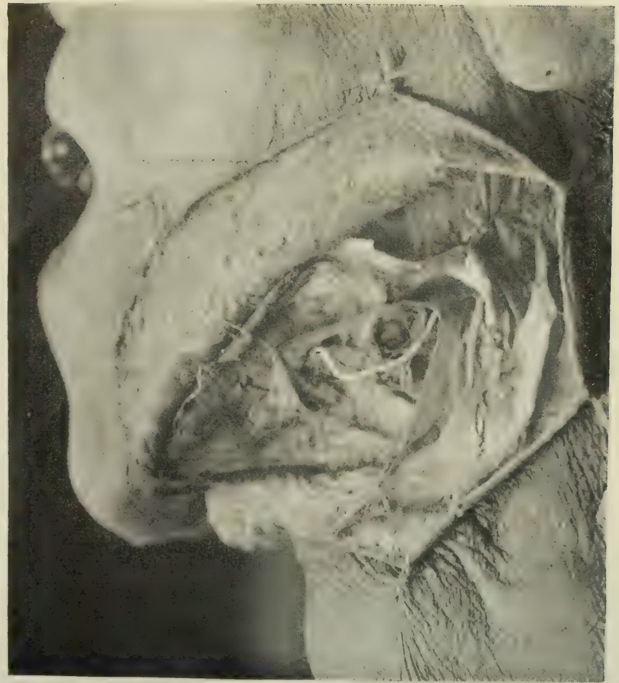
Paralysis of depressor labii inferioris (right) following extensive submaxillary dissection.

FIG. 2



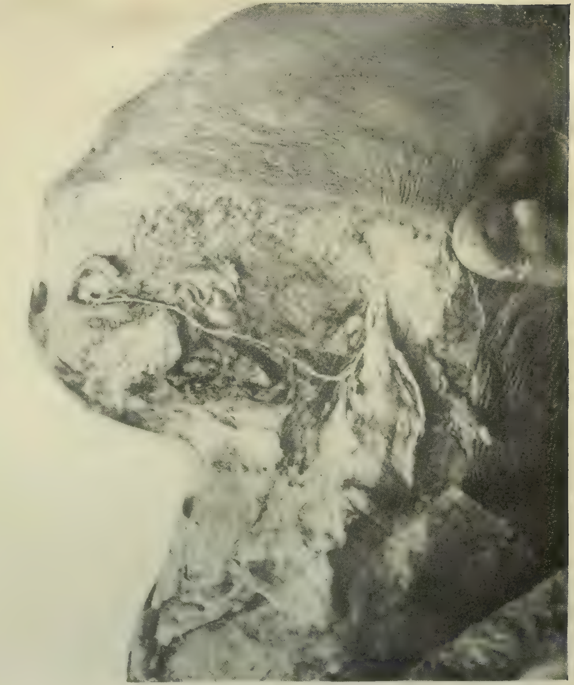
Outline of inferior branches of the facial nerve. Scar of extensive dissection for tubercular nodes.

Fig. 3.



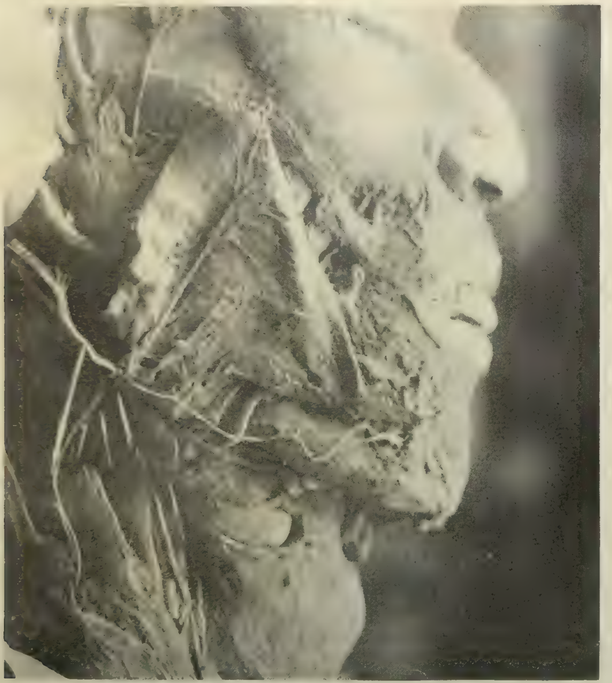
Submaxillary dissection. Deep fascia incised and retracted, exposing submaxillary branch and the salivary gland in its pocket in the deep fascia.

Fig. 4.



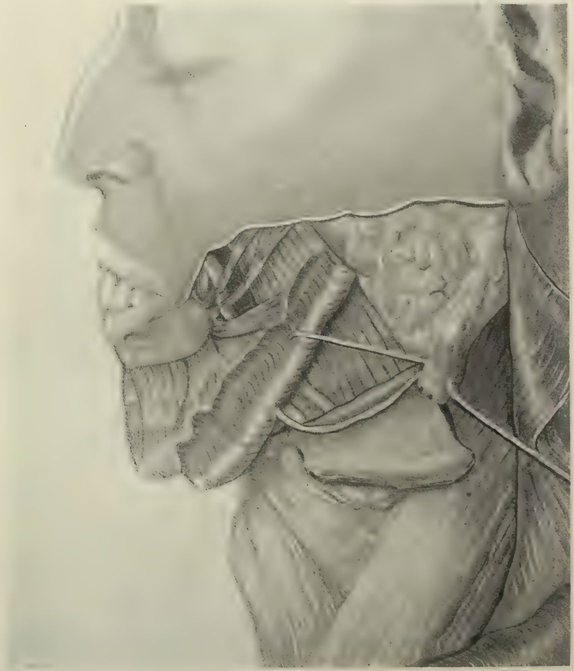
Tubercular submaxillary nodes just beneath the nerve.

FIG. 5.



Platysma turned upward. Deep fascia removed, exposing submaxillary branch and facial vessels, submaxillary nodes and salivary gland. Anastomosis between facial and cervical nerves.

FIG. 6.



Submaxillary branch to depressor muscles, transverse and descending branches to platysma. Deep cervical fascia turned downward.

# ANÆSTHOL POISONING CAUSING ACUTE YELLOW ATROPHY OF LIVER AFTER OPERATION FOR ILEOCOLIC INTUSSUSCEPTION.*

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In the last few years cases of delayed chloroform poisoning have come to our notice from time to time. The main lesion in these cases has been acute yellow atrophy of the liver. In many of them there had been suppurative processes within the peritoneum, thus rendering it uncertain whether these suppurations or the chloroform were the cause of the acute yellow atrophy, inasmuch as that affection has also been observed after operations for intra-abdominal suppurative processes, where ether was used. The case I am about to describe is one in which that element of doubt is eliminated, as there was no suppurative process found at the operation, nor did any develop afterward, as the autopsy showed. This case therefore appears to be an uncomplicated instance of delayed chloroform poisoning.

Oscar S., druggist, aged thirty-six years, was admitted to the German Hospital on December 24, 1909. Three weeks before that date he had been attacked with severe paroxysmal pain in the right iliac fossa together with vomiting and diarrhœa. Appendicitis had been suspected at that time. The symptoms subsided soon and the patient went to work again. After a week or so the paroxysmal colicky pains recurred, but were slightly higher up, about corresponding to the region of the gall-bladder, and a mass was felt under the liver, so that this time cholecystitis was suspected. A day or two later he vomited several times, the vomitus containing biliary matter and at one time blood. The stools also contained blood. At the same time the mass in the right hypochondrium was no longer felt, and the existence of a perforation of the gall-bladder into the duodenum was considered as a possibility. The patient improved in a few days and went to work again.

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* Read before the Clinical Society of the German Hospital and Dispensary, December, 1909.

On December 24 he had a severe recurrence of his attack of pain, this time combined with constipation. Physical examination revealed resistance of the recti, more particularly the right. There was tenderness on pressure. A large sausage-shaped mass could be felt extending across the upper part of the abdomen; it seemed to change its shape somewhat with the attacks of pain. As the obstruction was evidently a chronic one, an attempt was made during the next two days to overcome it by high oil and soap enemata, but without avail. On December 27 an operation was performed. An ileocolic intussusception was found extending almost to the splenic flexure of the colon; but the left portion of the colon was drawn over toward the right side, so that the tumor lay more on the right side than on the left. Disinvagination was now proceeded with by gentle manipulations of expression begun at the left portion of the transverse colon and working from there to the right and then downward in the direction of the right iliac fossa. Good progress was made until a portion of the appendix came into view; here the intussusceptum was held firmly within the intussuscipiens by strong adhesions. By cutting these with the knife the intussusceptum could be released a little more; but then it was seen that the cæcum was partly gangrenous, and the attempt to disinvaginate further was given up. A lateral anastomosis was now made between the ileum and the transverse colon, followed by a resection of the cæcum with half the ascending colon and a small portion of ileum. The cut ends of the intestine were closed by inverting them, two rows of silk sutures being used.

The relief experienced by the patient was immediate; he expressed it by the remark that he felt as though he were in heaven. His temperature at the end of twenty-four hours was 102.8, his pulse 140, respiration 24. From this time on the temperature steadily declined; after forty-eight hours it had reached 99.8 and after that became normal. The pulse, however, remained high, around 120. During all this time the patient felt very well and looked well. In the morning of the third day the patient became restless and would occasionally scream loudly. When asked, he could give no reason for his shrieking; but from his facial expression it was evident that in his imagination something must have badly frightened him. At this time slight jaundice appeared in his conjunctivæ. He soon became delirious, then stupor set in, and his breath assumed an acetone odor, so that now he had all the characteristic symptoms of acute yellow atrophy. A venesection was now made, followed by saline infusion, but without any effect on his condition. The stupor deepened into coma in which he died on the fourth day. Shortly before death the temperature had risen to 100.

The autopsy revealed an acute fatty degeneration of the liver. The surface of the liver was smooth, the capsule not wrinkled, the cut surface bright yellow with evenly mottled bright red spots; the interstitial tissue was not increased. The peripheral zones of lobules were represented by yellow material. The organ felt greasy and was doughy in consistency. The kidneys showed the signs of acute diffuse nephritis. The portions of intestine at the site of the operation were in good condition. There was no peritonitis with the exception of a slight local patch resulting in an adhesion of the omentum to the ileocolostomy (I had wrapped the omentum around that part, in order to make it adhere). The myocardium was flabby.

It will be seen that in all the characteristic points the history of this case corresponds closely with the histories of other cases of acute yellow atrophy that have been described, the apparent well-being in the first days, followed about the third or fourth day by jaundice, restlessness, delirium, acetone breath, stupor, and coma. In the absence of any suppurative process within the abdomen it is fair to assume that in this case the acute yellow atrophy was due to delayed chloroform poisoning, the deleterious action of the chloroform on the liver being enhanced by a congestion in the portal circulation caused by the intussusception. The existence of such congestion was evidenced by the fact that the patient vomited blood, although there was no lesion in the stomach or duodenum, as the autopsy showed.

The anæsthetic employed in this case was anæsthol, a fluid the composition of which is about as follows: ethyl chloride 17 per cent., chloroform 35.9 per cent., ether 47.1 per cent.

Eggers (German Hospital "Festschrift") has also published a case of acute yellow atrophy after an operation during which anæsthol was employed for narcosis. It has long been known that ether is a safer anæsthetic than chloroform. When anæsthol was brought out, it was believed by some that the danger of chloroform had been removed by this new combination. But we have seen deaths on the operating table where anæsthol had been given, and the cases reported by Eggers and myself show that one of the remoter results of chloroform poisoning will also not be avoided by using anæsthol. It seems therefore that, in estimating anæsthetics from the view-point of danger, a narcosis with anæsthol should be considered as being a chloroform narcosis.

# THE SURGICAL ASPECT OF EPULIS AND SARCOMA OF THE JAW.*

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THERE are many conditions of the jaw the pathology of which differs to such an extent that surgical measures must depend necessarily upon the characteristics of the tumors or diseases in question. The relationship which exists between the class of growths termed in a broad sense "epulis" and other more malignant tumors is an important one. In this paper, attention will be directed only to the connective-tissue tumors of the jaw, and those derived from epithelial structures or the conditions due to faulty development of the teeth will not be considered.

The term epulis signifies a tumor springing from the gums, and although the word has been condemned justly because of the confusion its use has entailed, it has become nevertheless so thoroughly a part of the nomenclature of jaw tumors that it cannot be excluded. Probably the greatest difficulty has been experienced in keeping clear the relationship of the highly malignant sarcomata which, springing from the deep tissues of the jaw, pursue a more unfavorable course than the relatively benign sarcomatous epulides. It becomes necessary, therefore, to properly understand such distinctions in order to describe the varieties of epulides and the sarcomata.

Epulis was used originally to describe any tumor which had its origin in the tissues of the alveolar process of the jaws, the term being used independently of the pathologic type of tumor. Thus carcinoma, sarcoma, and various benign tumors, such as myxoma, chondroma, fibroma, etc., were included. The tendency in more recent times has been to describe as an epulis only the sarcomatous and fibromatous tumors originating on the alveolar margin, and to designate the other tumors in this region by their true pathologic name. Because of their less malignant tendency, the sarcomatous forms of epulis are thus properly excluded from other more dangerous forms of sarcoma, but the term " epulis sarcoma " or " epulis fibroma " should be employed rather than simply to use the vague term " epulis." It is particularly desirable to separate from the epulides the carcinomatous type which is occasionally encountered, because it presents altogether a different clinical course from the sarcomatous epulis.

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* Read before the Philadelphia Academy of Surgery, April 4, 1910.

The histologic examination of collected cases of epulis shows a varied picture. Kühner, in his series of 31 cases, found 20 giant-cell sarcomata, 2 spindle-cell sarcomata, 4 fibrosarcomata, 2 fibromata, 1 osteoma, and 1 granuloma. The proportion of giant-cell sarcoma, about two--thirds of all the cases, corresponds to the observations of most writers. Hesse in a recent contribution, however, has disputed these facts, for he found that of 113 cases of epulis, 30 were sarcomatous, and by far the most common form encountered was fibrous in nature. This difference is explained by the fact that the majority of these cases were seen in a dental clinic, where the small and painless tumors are most commonly encountered, whereas the more rapidly growing and consequently more malignant forms are usually referred to the surgical clinics.

Histologically, giant-cells are found in enormous numbers in the majority of cases, the chief constituent of the tumor being composed of spindle- or round-cells. The tumors contain considerable blood pigment and extravasated blood, and at times are quite vascular, thus explaining their brownish-red color. Spicules of bone are common constituents of the growth, a fact which indicates that the bone-forming layer of the periosteum is involved in the growth of the tumor. An epulis occasionally arises from the submucous connective tissues, or in the peripheral layers of the alveolar process, and by growing externally appears beneath the mucosa.

The sarcomatous epulis is a pedunculated tumor, dark red in color, more or less movable, and may cause distortion in the outline of the teeth as it enlarges. The mucosa covering the tumor is intact in the early stages, but sooner or later shows points of erosion due to local traumatism, from which slight hemorrhage may occur. The tumors are usually soft in consistency, but may be firm and hard when of the fibrous or the fibrosarcomatous type.

The statistical studies of Kühner, Gunzert, and others, show a marked predisposition of the female sex, in whom two-thirds of the cases occur. While the disease may be seen at any time of life, it is most commonly encountered in the second, third, and fourth decades, although it is not uncommon in younger and older individuals.

Among the factors chiefly concerned in the etiology of epulis, caries of the teeth may be mentioned as the most prominent. The irritation of ragged, irregular, diseased teeth plays an important rôle in the formation of these growths, and such a history will be obtained from the majority of patients. In the instances in which extraction of a diseased tooth has been followed by the formation of a tumor, it is likely that the traumatism was sufficient to cause active growth of cells left behind after the removal of the tooth. This is especially likely when we bear in mind the tendency of the tissues of the mouth, the mucosa and the periosteum of the alveolar process to react to any sort of irritation. It should be mentioned, however, that epulides occur in the presence of sound teeth and under proper oral hygiene, neglect of which seems to act as a predisposition to the formation of the tumors. The influence of pregnancy in the development of an epulis has been repeatedly mentioned; the association, while difficult to explain, seems to be more than a mere coincidence. Finally the effect of artificial teeth, the irritation of pipe smoking, and other forms of long-continued traumatism may be mentioned as possibly having some etiological importance.

Clinically the tumors rarely cause serious symptoms. The jaw may be infiltrated in the late stages of the disease and absorption of the cortex arise; it may extend to the antrum or nasal cavities, displace the tongue, or cause protrusion of the lips. In the very large tumors, difficulty in chewing, swallowing, and speaking may be caused. Pain, which at times is complained of, is due to the diseased condition of the teeth. Repeated traumatism may cause hemorrhage from the more vascular growths, which in time may cause a moderate degree of anæmia. The ulcerative condition of the gingival mucosa may play a rôle in causing more rapid enlargement of the epulis.

The benignancy of this class of neoplasm is well demonstrated by the fact that metastasis to the regional lymph-nodes occurs practically in advanced cases only. The enlarged nodes seen in the course of an epulis are usually of inflammatory origin, and are caused by infection absorbed from carious teeth. In many instances the nodes disappear after extirpation of the tumor, and in those cases in which the enlarged lymphatics were removed with the tumor, microscopic examination has failed to reveal malignancy in the nodes.

The tumor generally exists for a considerable period before operative intervention is carried out; in most instances a year or more may elapse until rapid enlargement of the epulis causes the patient to seek surgical aid. Perthes is inclined to place little weight in the view that the giant-cell tumors are less rapid in their growth, because he has observed cases of the same histologic character, in which marked difference in rapidity of the enlargement has been present.

It is a well-known fact, that whereas epulis is a tumor benign in nature from the clinical stand-point, it tends to recur when insufficiently removed, and in such cases the recurrent tumor may take on a more rapid growth. Kühner records 11 recurrences in 90 cases of epulis—the operation in this series removed only the visible tumor tissue and not the portion of the alveolar process from which it sprang. If secondary operations are carried out promptly, the chance of ultimate cure is good, for instances are on record in which repeated operations have finally resulted in a cure.

That the prognosis is good is shown in the very large percentage of cures which ranges from 75 to 97 per cent. An important observation was carried out by Kühner in four of the cases not undergoing operation for the radical removal of the epulis. He found that three died from the effect of the tumor, one of general sarcomatosis; the second, a man fifty-four years of age, of extensive recurrence; and the third, a male aged sixty-six, from blood poisoning originating in the epulis. In the fourth case, a boy aged five, spontaneous healing occurred and persisted for a period of 25 years. From these cases and similar observations, it is apparent that epulis, if neglected, may become highly malignant, and resemble in this particular the sarcomatous growths of the jaw.

*Fibroma.*—This affection appears as a central growth, or it may arise from the periosteum and appear as an epulis of the fibrous type. The growth has many of the characteristics of the sarcomatous epulis, but appears harder and more compact, owing to the large amount of fibrous tissue in its structure, which accounts for its lighter color. In some instances the cells of the tumor are so abundant that the growth is quite soft, resembling a sarcomatous epulis for which it is mistaken at times. Eve holds the opinion that most of the so-called fibrous epulides are sarcomata, for in his series of cases a pure fibrous epulis did not exist. This, however, does not correspond with other observations; I have studied two cases in which there was no evidence of sarcomatous tissue in growths which were classified as fibrous epulides. Gunzert described myxomatous degeneration of the tissues which is particularly prone to arise in the tumors of long standing. The base of the epulis may contain lime salts or spicules of bone. While the tumors are usually small, they at times reach a large size and are dangerous from a mechanical stand-point. Sudden enlargement is indicative of a malignant degeneration, *i.e.*, sarcoma. Perthes calls attention to the tendency of the fibrous epulis to appear as multiple growths affecting both jaws.

The central variety of fibroma differs as greatly from the fibrous epulis as does sarcoma from a sarcomatous epulis. The growth, according to Perthes, may occur in either jaw, but is more common in the lower. The tumor takes its origin from the central part of the bone, and as it grows the periosteum and cortex become expanded over it, forming a thin shell, or the rapidly growing tumor may be covered with a layer of tissue containing bone trabeculæ derived from the periosteum. The tumor may be firmly attached to the bone covering it or lie free in the cavity. When seen in the upper jaw, the tumor tends to spread toward the antrum, or may arise primarily in that situation.

The growth of a fibrous epulis is essentially a slow one, it may occupy many years in its development, and most commonly occurs in the third and fourth decades of life. The enlargement does not, as a rule, produce pain unless pressure is exerted upon nerves, as, for example, infra-orbital neuralgia may occur in the fibromata of the upper jaw. There is no tendency of the tumors to metastasize, ulcerate, or infiltrate the surrounding tissues, all of which point to its benign nature. Secondary infection and necrosis have followed exploratory incision in a fatal case recorded by Heath.

The diagnosis depends largely upon the gradual growth and painless course of the fibroma. If the tumor is attached to the lower jaw, distending it, and if surrounded by a shell of bone, the differential diagnosis between it and other benign growths will be difficult, and may only be made by aid of a Röntgen examination. The differential diagnosis may also be difficult in slowly growing myxosarcomas in the same location.

The operative measures in these cases demand complete removal of the tumor and the portion of bone to which it is attached. Only in exceptional cases will it be necessary to do total resection, and then only when the size of the growth prevents less radical measures. Following partial resection of the jaw and the tumor, the results have been satisfactory, since the benign nature of the fibroma excludes the possibility of a recurrence.

*Sarcoma.*—Sarcoma of the jaw occurs less frequently than carcinoma, the proportion being about two cases to the former to three of the latter. The relative frequency of sarcoma of the jaw is shown by Gurlt's statistics in which 14,630 tumors included 532 growths of the jaw, and of the latter 179 were sarcomata, 96 occurring in the upper jaw and 63 in the lower. From these statistics and other observations, the upper jaw is found to be the more common site of the tumor. As already noted in the sarcomatous epulis, the female sex is more often affected; the same relative proportion is observed in the jaw sarcoma. In Perthes's collected statistics of 126 cases, 55 were men and 71 were women.

Trauma seems to play an important rôle in the etiology of sarcoma. Whether the effect of injury is manifested by the stimulation of tumor cells already present, or whether the trauma is even more intimately concerned in the origin of the growth, is difficult to prove. The cases which I have studied show in several instances that trauma played a part in the development of the tumor. In one instance a very large sarcoma began its initial growth several months after the extraction of two teeth and reached its maximum size in eight years. It is possible in this case that the effect of trauma was manifested by increased rapidity in growth of cells, which were present at the site of the diseased teeth, but which were more or less inactive previous to the traumatism. In another instance, a boy aged twenty-two was injured while boxing, and several of the lower teeth were loosened. After this accident tenderness was present for several months, and then swelling of the jaw arose. This condition lasted for three years, when rapid enlargement took place, so that four years after his accident a definite mass the size of a hickory-nut projected from the middle of the ramus of the lower jaw. This tumor and the adjacent portion of the jaw were removed by Dr. C. H. Frazier, and on microscopic examination was found to be an osteosarcoma of a low degree of malignancy.

Histologically all varieties of sarcoma occur and follow the general rule that the smaller and more abundant the cells, the greater the degree of malignancy, as manifested by rapidity of growth, metastasis, and tendency to recurrence. The giant-cell sarcomata are the least malignant and resemble the tumors of similar structure found in other bones in respect to their slow and relatively benign course. In contrast to the simple forms of sarcoma, those in which cells of the original embryological jaw structure are reproduced present a more varied picture. Thus chondrosarcoma, fibrosarcoma, and osteosarcoma are met with, all of which possess a greater or less degree of malignancy, depending upon the number and size of the sarcomatous elements.

A curious tendency of the last named type lies in the formation of highly malignant secondary growths composed of pure sarcomatous tissue, in which the bone or cartilage may not be reproduced. In general it can be said that sarcoma of the jaw has but a slight tendency to metastasize to the regional lymphatics draining the area and tends still less to spread to the viscera. Enlargement of the cervical nodes may be present, but in many instances it is the result of infection rather than a secondary tumor formation. It is not an uncommon experience to see enlarged nodes disappear after the jaw tumor is excised, although it is a safer and more scientific surgical principle to remove enlarged nodes, as in any radical operation for the cure of a malignant tumor.

The symptoms produced by the peripheral form of sarcoma differ somewhat from the central variety. The latter tends to produce more or less hard, rounded, circumscribed tumors which generally enlarge toward the outer surface, and may be mistaken for dentigerous cysts. Later in the course of the growth, the cortical layers of the compact bone become rarefied, and the crackling sensation common to central sarcoma of bone may be produced. As the tumors enlarge, pressure symptoms develop, thus œdema of the eyelid and mucous membrane of the antrum, dislocation of the eyes or teeth, dilatation of the superficial facial veins, obstruction of the nasal duct, and difficulty in speaking and swallowing may occur. The periosteal tumors present a somewhat different picture, in that the shape of the growth varies, it takes its origin directly from the periosteal covering of the jaw, a fact easily demonstrable on palpation. In the early stages the mucosa is intact, the growth is painless until it undergoes ulceration or the infiltration of the bone causes pain. Pain is also seen in the neoplasms which press upon nerves. Neuralgic conditions of the teeth may arise and direct attention to the cause, a beginning sarcoma.

The operative indications of jaw sarcomata depend on the histologic type of tumor and the extent of the growth. Perthes's statistics based upon the results obtained in several clinics lead us to conclude that, after a period of three years, a third of the cases of total resection of the jaw for sarcoma will remain well. One-half of the patients develop recurrence, a fact which demands still more radical measures in treating these cases. It must be stated, however, that partial resection of the jaw has met with considerable success, but too great emphasis cannot be laid upon the class of cases for which this operation is indicated. The small, well-circumscribed, giant-cell sarcomata situated on the alveolar margin of the upper jaw, irrespective of epulis, and sarcoma of the hard palate may be partially resected. Similar growths on the alveolar process of the lower jaw may be treated in the same way, but all other forms of sarcoma should be subjected to total resection. The percentage of cures in these cases will increase if we operate at an earlier period, before the growth has involved a large area of the bone. The slight tendency toward regional or general metastasis should prove of great value in favoring early operation, and markedly assist in cure because of the lessened possibility of recurrence.

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# THE USE OF DIFFERENTIAL PRESSURE IN THE TREATMENT OF EMPYEMA.*

BY E. M. VON EBERTS, M.D., M.R.C.S. (Eng.),

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As the bar to progress in thoracic surgery has been the danger of lung collapse, clinical advance in this field has awaited the invention of a certain and practical means of preventing pneumothorax. This difficulty is now overcome, and there are already well-recognized procedures in which the use of differential pressure is a necessary part of the technic. Among such, one might mention the removal of tumors of the thoracic wall, pleura, and lung; exploration of the pleural cavity for foreign bodies; excision of the whole or part of a lobe for bronchiectasis; and gastro-œsophagostomy for malignant disease of the cardia or benign or malignant stricture of

Fig. 1.

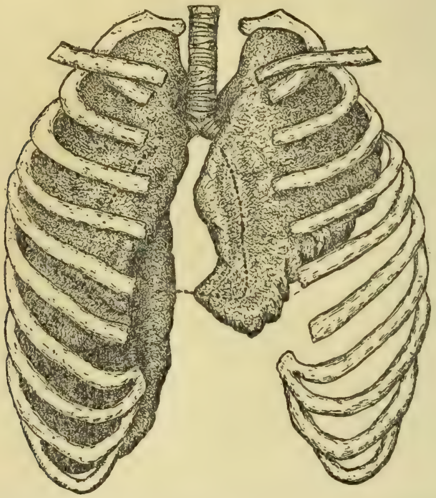

Diagram showing pressure effects of pleuritic effusion upon the respiratory viscera and mediastinal structures.

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* Read before the Canadian Medical Association at Toronto, June, 1910.

the lower extremity of the œsophagus. The widest field, however, for the application of differential pressure is found in the treatment of empyema, where, by its means and by the application of a suitable dressing after thoracotomy, the period of disability may be very greatly curtailed. At the time of operation and at subsequent dressings, positive differential is especially suitable, as with a portable apparatus not only hospital cases but also cases operated upon in private homes may enjoy the benefit of this method of treatment.

FIG. 2.

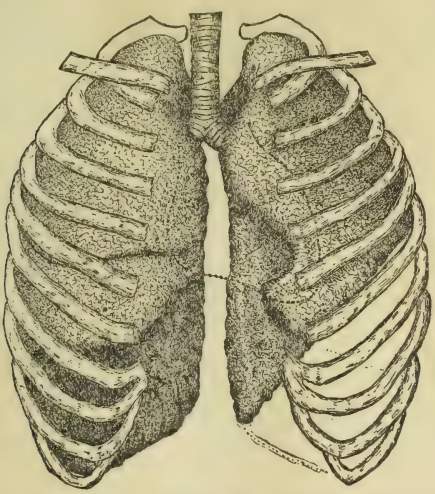
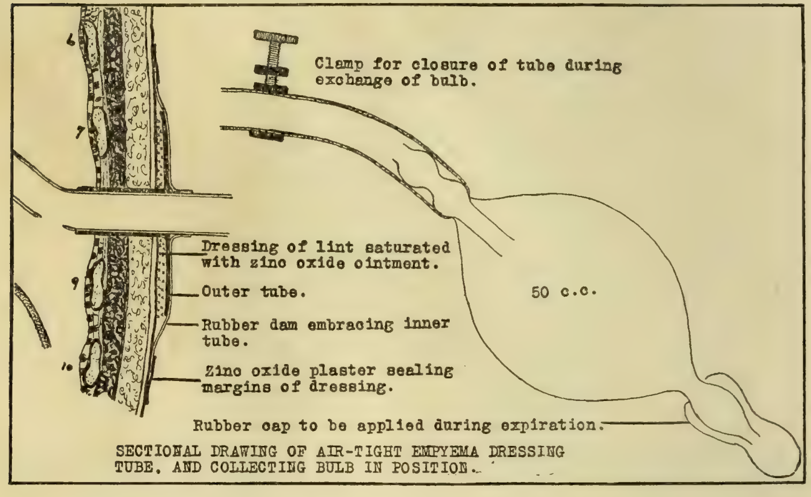


Diagram showing correction of alignment of mediastinum and restoration of normal contour of lung on the unaffected side under differential pressure and in the presence of thoracotomy. The lung on the affected side also shows a slight increase in volume.

The accompanying illustrations convey graphically the effects of differential pressure in the treatment of empyema (Figs. 1 and 2). Following thoracotomy an empyemic cavity remains exposed to atmospheric pressure. In extensive cases the whole lung may be collapsed and may lie in close apposition with the mediastinum. Further, the mediastinum and pericardium are not infrequently displaced toward the sound lung. Under such conditions, each inspiratory act results in the deflection of the mediastinal septum and collapsed lung toward the sound side, in response to the negative tension produced on that side during inspiration. On consideration, it is quite evident that the mediastinum and exposed viscera must tend to move away from the cavity so long as the tension within the cavity remains greater than the average intrapulmonic tension. This fact partially explains why, in long-standing cases, the collapsed lung fails to regain to any extent its functional activity. In these cases the empyemic cavity is eventually obliterated by the formation of scar tissue within, and through its contraction, the approximation of the various anatomical structures forming the boundaries of the cavity, that is the mediastinum, the diaphragm, and the chest wall. We are all familiar with the resulting deformity. In the fact that the mediastinum tends to oscillate towards the sound lung during inspiration, we have the explanation of the cyanosis and rapid respiration so frequently present after thoracotomy for empyema. An inspiratory deflection of the mediastinum toward the sound lung must necessarily nullify, in direct proportion to its degree, the end result of inspiration by lessening the area and amplitude of infundibular inflation.

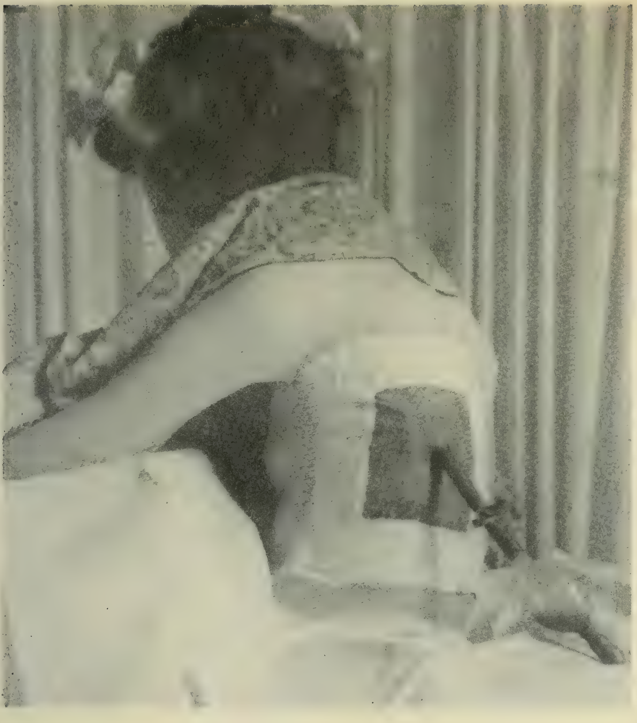
FIG. 3.


6
7
9
10
Clamp for closure of tube during exchange of bulb.
Dressing of lint saturated with zinc oxide ointment.
Outer tube.
Rubber dam embracing inner tube.
Zinc oxide plaster sealing margins of dressing.
50 c.c.
Rubber cap to be applied during expiration.

SECTIONAL DRAWING OF AIR-TIGHT EMPYEMA DRESSING TUBE, AND COLLECTING BULB IN POSITION.

With the use of differential pressure and the application of an air-tight dressing, such as the one which I have devised (Figs. 3 and 4), not only is the mediastinal deflection reduced

FIG. 4.



Photograph of case showing air-tight dressing, tube, and collecting bulb *in situ*. This case, one of pyopneumothorax in a girl aged fifteen years, presented complete collapse of the left lung of eight days' duration. The bronchial communication had closed at the time of operation, and while hypertension (15 mm Hg) corrected the mediastinal deflection, it failed to expand the lower lobe. Obliteration of this large cavity was effected under constant negative tension in twenty days through expansion of the upper lobe and approximation of the mediastinum, diaphragm and chest wall,—the lower lobe remaining in an atelectatic condition.

and the cavity thereby diminished in size, but the air within the abscess cavity becomes negative in tension during inspiration, and, in consequence, the mediastinum and pericardium tend to be further deflected toward the cavity and the collapsed lung to expand in the same direction. An immediate result of such a method of treatment is the prompt relief of the cyanosis. Subsequently, day by day, there is an appreciable diminution in the size of the cavity. Not only does this dressing do away with the foul odor in the sick room, but as will be seen by the chart, the amount of discharge may be accurately tabulated.

FIG. 5.

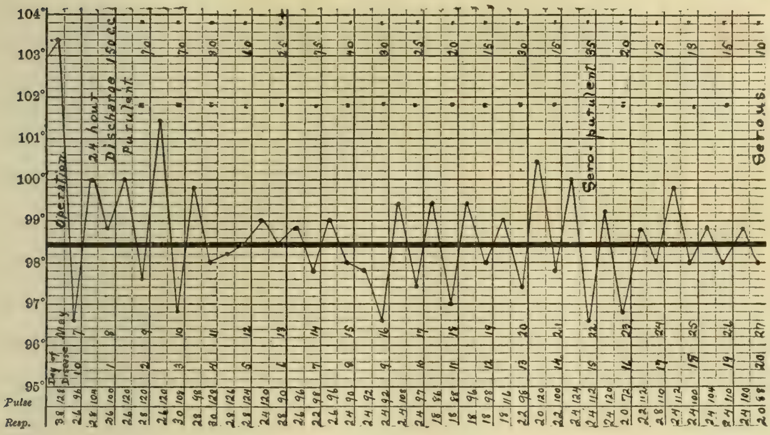


Chart from case (Fig. 4) of pyopneumothorax, showing the daily amount of discharge.

The collecting bulb in this way becomes an instrument of precision. If the discharge shows a gradual decrease and the temperature remains normal, one may be satisfied that there is no pocketing or retention of pus. On the other hand, if there is a rise in the temperature curve, a definite knowledge of what the amount of the discharge should be may give one a clue to the cause. Apart from the curtailment of the period of disability, the absence of odor and of the pain and discomfort of prolonged dressings, the earlier restoration of the collapsed lung to its normal respiratory activity may remove to a large extent the danger of a subsequent tuberculous infection.

# PRIMARY SARCOMA OF THE STOMACH.

## WITH REPORT OF TWO CASES.

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AND
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THE interest of these two cases centres, first, in the fact that they are examples of a comparatively rare type of disease; second, that they presented symptoms of marked disagreement; and, third, that neither gave indications sufficiently suggestive of the pathological lesions existent. Without further comment, the history of each case will be first given.

CASE I.—Miss A. P., aged fifty-seven years, a teacher by profession, was seen in consultation with a local practitioner. The case was considered probably one of a large ovarian cyst, and the patient was accordingly removed to a private nursing home for operation. She was admitted in October, 1909. She had always enjoyed good health, and with the exception that she had recently suffered from occasional attacks of frequency of micturition, her only complaint was one of increasing discomfort from enlargement of the abdomen. She was perfectly clear and emphatic regarding the entire absence of any gastric symptoms, and being a particularly intelligent lady such a statement may be regarded as possessing the truth. Menstruation had ceased two years previously. Prior to that her periods had been regular and normal, accompanied only with some pain on the first day. Since the menopause there had been no symptoms referable to the uterus. Her previous history was free from any disturbances of a local or constitutional character. The lower part of the abdomen was very prominent, and a large swelling could be felt filling the hypogastric and lower umbilical regions with a leaning towards the right flank. The tumor felt quite smooth on the surface and appeared movable. There was no indication of fluctuation. Pressure caused no pain, nor from the regularity of her bowels did it seem to have any obstructive effect upon the intestines. Both flanks were resonant. An examination *per vaginam* revealed a small but freely movable uterus; both fornices were empty, and the tumor seemed to be entirely without the pelvic cavity.

The abdomen was opened by a curved incision below the umbilicus. A smooth rounded tumor was at once encountered presenting a somewhat dark mottled and striped appearance. The hand introduced into the abdomen felt a nodular projection at the upper part, with attachments below to the omentum and above to the stomach. The growth was felt to be free from any connections with the pelvic viscera. A small median incision carried upwards permitted the tumor to be brought out. After tying off the few omental adhesions, the growth was then discovered to be united by a solid pedicle, about the diameter of the thumb, to the greater curvature of the stomach some two inches or so from the pylorus. The part of the gastric parietes involved was excised, and the aperture closed by a double row of sutures. The patient made an uninterrupted recovery.

The specimen when examined after removal was found to be a large unilocular cystic tumor with smooth external wall, and filled with laminated clot. It measured 14 x 14 x 11½ cm., and was adherent to the wall of the stomach. A portion of the stomach wall with tumor tissue invading it, of the size of a walnut, was also submitted for examination, and on section presented a somewhat gelatinous appearance with healthy-looking mucosa covering it. Section of the wall of the cyst showed, under a low power, a fibrous stroma supporting a cellular element. In parts of the section the structure was of a somewhat loose character; in others more dense and cellular. At the periphery the fibrous character was more apparent, and the outer part of the tumor area had an appearance not unlike that of a spindle-celled sarcoma. In the central part of the section thin-walled congested vessels were fairly abundant, and extravasations of red blood-corpuscles were also apparent. Spaces resembling fat cells were also seen in the section. With the high power the characters of the cells which composed the tumor were found to fall into two groups—cells of connective-tissue origin, fibroplastic and definitely spindle in shape; and larger cells of spherical shape with sharply staining nucleus and a large protoplasmic body deficient in chromatin. Well-formed blood-vessels were present in the section, and in a few places small nodules of lymphoid cells were also present. The characters of the section would suggest a tumor of mesoblastic origin, viz., a mesothelioma. Microscopic examination of the stomach wall showed that the mucous membrane and submucous layers were unaffected by the tumor involvement, but the muscular wall showed extensive infiltration. Areas of tumor cells extended between the muscular bundles, and in parts replaced them. Under the high power the same character of cells was noticed as above described in the cyst wall, but the larger spherical cells were more abundant.

Case II.—R. H., aged sixty-three years, was admitted to the Victoria Infirmary in July, 1903, suffering from a tuberculous stricture of the rectum. At this time there were no gastric symptoms, his trouble being entirely referable to the rectum. The stricture was successfully excised, and he remained well for some years. He then began to be troubled with prolapse of the rectum and some incontinence of fæces. For this he was again admitted to the Infirmary in September, 1909, *i.e.*, six years after his first admission. During this period of residence he complained of very distinct gastric symptoms—he had a distaste for food and felt occasional pain in the epigastrium; the latter, however, seemed to have no association with the ingestion of food. He did not vomit, nor did he feel any inclination to do so. There was no tenderness in palpating the epigastrium, nor could anything be felt; he was, however, quite definite and positive in his statement that a lump occasionally appeared on the "left side of his belly" just below the costal margin. As the condition of the bowel was solely under consideration, the gastric symptoms did not receive the amount of attention they deserved. He was in a very low and enfeebled state of health, and succumbed after the operation attempted to relieve the prolapse. A postmortem was obtained, when the following conditions in connection with the stomach were found:

Adherent to the stomach was a large cystic tumor, somewhat larger in size than a child's head, springing from the greater curvature of the stomach, with smooth external wall, unilocular, filled with blood-stained fluid, and soft tumor tissue resembling in appearance partly organized blood-clot. The mucosa was healthy. The microscopical examination of the tumor showed its character to be that of a spindle-celled sarcoma, fairly dense in consistency. Throughout the section were noted a number of new-formed thin-walled vessels filled with blood, and in parts extravasations of blood were seen. The section through the stomach wall showed tumor infiltration of the serous and muscular coats. The mucosa was found uninvolved. There were no evidences of tumor formation in any other part of the body.

*Remarks by Mr. Maylard.*—Primary sarcoma of the stomach, as judged by recorded cases, seems a very rare disease, and more particularly so if the pyloric region be excluded. In other words, cases such as those just described, of well-defined and distinct non-ulcerative growths springing from the mid-gastric parietes, are extremely exceptional. Probably one of the earliest recorded cases, or, at least, one of the earliest successful cases of removal of a tumor of this nature from the stomach, is that of Billroth's in 1881. Since then isolated cases have from time to time been reported, and if foreign records be excluded, very few have been published in the English language. In the past they appear to have been more frequently met with in the post-mortem room than in the operating theatre; and a really correct appreciation of the frequency of the disease, therefore, could only be obtained by a combined investigation of surgical and pathological records. There are two published cases which I will refer to more particularly, because in certain points they markedly resemble my own. In one, recorded by Hartley (ANNALS OF SURGERY, vol. xxiii, 1896, p. 609), the tumor was a spindle-celled sarcoma, like, therefore, my second case. In the other, recorded by Cantwell (ANNALS OF SURGERY, vol. xxx, 1899, p. 596), the clinical resemblance to my first case was most striking; in neither were there any symptoms attributable to the stomach, indeed, the sole complaint made by each was the increasing discomfort engendered by the abdominal distention. Strangely, also, a further agreement existed in the fact that in both instances it was thought likely that the tumor was connected with the genital organs. I must own that no other thought entered my head; for although a vaginal examination showed the pelvic organs free, it simply left the impression that the supposed ovarian cystoma had swung itself free of the cavity of the pelvis. We were further misled by the patient's statement that she first noticed the swelling in the right flank. It must be deemed a remarkable fact, as much in my own case as in that of Cantwell's, that such large tumors could hang from the gastric parietes without interfering with the normal functions of the viscus and causing some sort of dyspeptic symptoms.

*Remarks by Dr. Anderson.*—Both the tumors presented a marked similarity in their external appearances, being cystic in character and covered by a smooth external peritoneal lining, and both springing by a definite pedicle from the wall of the stomach, the mucosa of which in both cases was uninvolved. The second case presented the definite microscopical appearances of a spindle-celled sarcoma; the first case, on the other hand, showed the presence of characters of a spindle-celled sarcoma and endothelioma in different parts. The following quotation from a paper upon the subject by MacCormick and Welsh (*Australasian Medical Gazette,* July 20, 1906) is of interest. These authors state: "It is sometimes hard to decide whether the growth has started in the stomach or has taken its origin in some adjacent structure. In the case of the spindle-celled sarcomata, they rarely present this difficulty of interpretation, and their origin in the submucosa is more generally accepted. They commonly take the form of localized growths which sooner or later project from the outer surface of the stomach, and when, as so often happens, they grow from the posterior wall, they pass into the lesser sac of the peritoneum, which they may come to distend. As they increase in size, they frequently become pedunculated and may form adhesions to adjacent structures."

It is in connection with the first case, in which both spindle and endothelial cells are present, that the difficulty arises. I described it in the account of one section as a mesothelioma, and from this I infer that it had its origin in or beneath the serous coat. Similar difficulties in reviewing the tumors of the round-celled sarcomata group have been experienced by the above-named authors; but here the question was whether the case was a primary sarcoma or secondary infiltration of the stomach wall of the nature of that seen in lymphocythæmia. But the clinical history and present satisfactory condition of the patient are more in favor of the opinion I have expressed.

# THE FUNCTION OF THE APPENDIX AND THE ORIGIN OF APPENDICITIS.

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SHORTLY after his death, a paper was published in the ANNALS OF SURGERY by Mr. C. B. Keetley about the function and value of the appendix. Both he and Sir William Macewen regard the appendix as a valuable actively useful organ not to be sacrificed lightly. Their opinions are based largely upon complicated clinical observations. Other observers, such as Mr. W. J. Mayo, incline to the other extreme: that the value and functions of the appendix are so small that they are absolutely inconsiderable when compared to the dangers which it may cause. When the enormous number of people are considered who have had their appendices removed and are in perfect health, one cannot but sympathize with the latter view put forward. Yet as a matter of scientific interest, the appendix has a function; and, when diseased and removed, that function is undertaken by neighboring tissue and the patient is relieved of a passive tube containing actively poisonous material. Such a view I advocated in the Erasmus Wilson Lectures delivered before the Royal College of Surgeons in 1904 [1] and, in view of Mr. Keetley's recent death, shall content myself with restating them. This is done in four sections: the natural history of the ileocæcal region, the physiology of the appendix, the development of the appendix, and the pathology of chronic typhlitis and appendicitis.

### THE NATURAL HISTORY OF THE ILEOCÆCAL REGION.

Food in the mouth is reduced by the action of the teeth to a more or less pulpy condition, in which state it enters the stomach, where it is further broken into fragments by the action of the hydrochloric acid, pepsin, and churning muscular movements. The casein of our primitive natural food, milk, is precipitated and also fragmented. The pylorus, the smallest portion of the alimentary canal, allows or should allow no large pieces to pass into the duodenum. The work of the stomach and mouth may be regarded as chiefly, if not entirely, preparatory to chemical digestion and absorption, and to partake of the physical nature of fragmentating the food. The more perfect the work of the stomach, the more completely will the food be reduced to a molecular condition, and consequently, the more perfectly will it be adapted for the chemical action of the bile and pancreatic secretions. The next twenty odd feet of the small intestine are given over to these chemical changes and the absorption of nutriment. The products of digestion having reached the ileocæcal valve, it is the duty of that sphincter only to allow water, soluble material, and very small pieces of indigestible débris to enter the cæcum. There are similarities in the physiologies, *i.e.,* homologies, between the pylorus and the ileocæcal valve. The former is the portal between fragmentation on the one hand and chemical digestion on the other; the latter stands between chemical digestion and specialized absorption on the one hand, and possibly excretion, and the absorption of water on the other.

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[1] "Clinical and Pathological Observations in Acute Abdominal Disease" (Constable & Co.), 1904.

Fluid or semifluid material is passed from the small intestine through the ileocæcal valve into the cæcum. The latter is not adapted for the carriage of fluid by peristalsis; it is too large and thin walled to contract efficiently, unless it is tightly distended like the bulb of a Higginson's syringe. In addition. in man, gravity works against it. As a result the fæces must remain in the cæcum until the absorption of water from them and the addition of mucus to them have rendered them of the proper consistency for their transit along the large intestine. Hence, it is easy to understand why the cæcum is so often the most capacious part of the large bowel, and why at operations, particularly for intestinal obstruction, surgeons so frequently find it distended out of all proportion to the rest of the alimentary canal, the bowels being full of fluid.

Hence, just as there is a natural pause for food in the stomach, so is there another for the products of digestion in the cæcum; and in both, the contents are prepared for their course in the next part of the alimentary tract. To turn to the pathological significance of this halt, pause, or rest, it will be seen at once that the cæcum is the breeding ground of bacteria, par excellence, of all parts of our intestine. The enumerations of the colonies from different parts of the alimentary tract bear this out, and have proved that colonies of bacteria are more frequent by hundreds and thousands here than in any other part of the intestinal tract, even after a period of starvation. And it is only to be expected that this difference will show manifold increase when food is taken. It is now very easy to understand why nature has established so large a storehouse of protective lymphoid tissue for the production of leucocytes in the ileocæcal region, to which the appendix is an intestinal "tonsil," an index of the fermentative processes which are going on within the cæcum, a culture tube for the bacteria therein contained. Hence the very great frequency of its inflammation—appendicitis.

It will now be seen that there is strife between the micro-organisms and lymphoid tissue in the cæca of every one. Hence the gradual disappearance of the lymphoid tissue as age advances. If the strife becomes a little more severe than it is ordinarily in health, some inflammation about the ileocæcal region will result, as after a dietetic indiscretion. In the great majority of cases, this inflammation shows itself as appendicitis. In consequence, appendicitis may be regarded as a result of the exaggeration of a process natural to the ileocæcal region of all.

## THE PHYSIOLOGY OF THE APPENDIX.

It has long been taught that this organ was functionless, and that most probably in this lay its apparent incapability to resist the attacks of disease. That it represents the terminal portion of the cæcum which has become differentiated in development is undeniable, but that it is functionless is undoubtedly untrue. Like the rest of the intestinal mucous membrane, that of the appendix has numerous glands whose secretion has apparently an insignificant digestive action on all foods. As little if any contents of the cæcum ever enter the appendix, any digestive action it has must be of the smallest, and its absorption of products of digestion cannot be greater.

To sum up this phase of intestinal physiology: in the small intestine the products of digestion are fluid and are being continuously passed onwards by peristalsis; the cæcum is the first great "resting place" for these products since they have left the stomach; the large intestine, as its name implies, is of greater calibre than the small and is more suited for the carriage by peristalsis of solid than liquid fæces; the cæcum being rendered less mobile owing to its peritoneal attachments and, in man, having to work semifluid material against gravity, the products of digestion have to remain in it until their consistence has become such as allows of their passage along the large intestine; the change in consistence is made by the deposit of mucus from the glands of the large intestine and by the absorption of water. In consequence, the cæcum of the child loses its tapering form and becomes larger by the development of pouches between the tæniæ muscularis. During this "pause" further quantities of digested material will be deposited in the cæcum and dilate that structure, possibly delaying the despatch of the first "fecal" contribution. Hand in hand with these processes will go the fermentative changes of myriads of micro-organisms, to whom the temporary stagnation offers opportunity of multiplication. Hence the far greater quantity of bacteria in the large than in the small intestine. The temporary delay in the passage of the intestinal contents, the absence of a secretion like that of the stomach, the presence of large quantities of active micro-organisms and their products point to the necessity for the development of a protective armament on the part of the host to counteract them. Hence the large development of lymphoid tissue in the terminal and most dependent part of the cæcum, *i.e.,* the appendix, and its specialization not degeneration. The need of the presence of this "intestinal tonsil" is apparent in the cæcal region. The comparative absence of lymphoid tissue in the rest of the large intestine is explicable, as it is in the cæcum that the fæces have been brought up to the proper consistence to allow of their passage along the colon, and in consequence there are no more prolonged periods of "rest" in the presence of moisture, the fæces becoming dryer and harder; consequently there will be less fermentative action.

Hence it may be said that: (*a*) Lymphoid tissue is the characteristic feature of the cæcal apex. The vermiform appendix of man is represented in the vertebrate kingdom by a mass of lymphoid tissue, situated most frequently at the cæcal apex. (*b*) As the vertebrate scale is ascended, this lymphoid tissue tends to be collected together into a specially differentiated portion of the intestinal canal, the vermiform appendix. (*c*) The vermiform appendix of man is not, therefore, solely a vestigial structure, though it undoubtedly represents the terminal part of the cæcum. On the contrary, it is a specialized part of the alimentary canal, nature having made use of a disappearing structure and endowed it with a secondary function by giving it lymphoid tissue to protect the body against the micro-organisms in the ileocæcal region.

## DEVELOPMENT AND LIFE HISTORY OF THE APPENDIX.

The development of this organ illustrates the previous contentions and can be studied both in the individual, ontogeny, and in the animal series, phyllogeny. That of the human fœtus will be given first.

Up to the third month of intra-uterine life the diverticulum of the primitive intestine, which subsequently becomes the cæcum, is of uniform calibre throughout. At this period its growth becomes unequal, the terminal portion failing to increase in size at the same rate as the proximal. The inequality thus established becomes more and more marked as time goes on. At birth the terminal part of the cæcum, or the appendix as it is called, forms a tapering prolongation of the cæcal diverticulum.[2] It is not until later that a definite line of demarcation is to be seen between the two structures. The fetal type of cæcum is, therefore, an inverted cone whose apex imperceptibly shades off into a prolongation of the appendix. It will now be seen that the appendix represents the terminal portion of the original cæcum.

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[2] Keith, "Human Development and Morphology."

Turning to the animal series for suggestions to aid in the explanation of this phenomenon, it is found that a distinct appendix is only seen in man, anthropoid apes, lemurs, and the opossum. On the other hand, it is common to find a lymphoid structure at the distal portion of the cæcum, which undoubtedly represents the appendix.[3] In the latter series of examples, the cæcum and its lymphoid appendage conform to the human fetal type. It is quite a later phase both in ontogeny and phyllogeny that the cæcum loses its conical form by the development of pouches between its three thin muscular bands. And it is by that that the appendix becomes distinctly separated.

As age advances the appendix undergoes changes both in position and structure. In the fœtus it is situated along with the cæcum under the liver, and later it descends into the iliac fossa. Sometimes it remains in its fetal position, or it may be arrested at any part of its descent. An examination of the appendices for different decades shows that they are both relatively and absolutely longest and thickest between the ages of ten and thirty. The walls during this same period are stuffed with lymphoid nodules. After the latter age the appendix begins to undergo a slow involution both in length and thickness. The lymphoid nodules disappear also, though more slowly and uncertainly.

Robert Morris[4] has directed attention to the association of pain, intestinal, and general symptoms with this involution. The change is certainly of a chronic inflammatory character such as would be expected to occur in nearly every one who has an appendix, and is the result of the continued irritative action of bacteria throughout years. Still more recently the occurrence of appendix-dyspepsia (its more modern name) has been rediscovered.

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[4] Morris, Am. Journ. of Obstetrics and Gynæcology, 1901, 439.

[3] Berry, Journal of Anat. and Phys., 1910.

## PATHOLOGY OF CHRONIC TYPHLITIS AND APPENDICITIS.

It is a matter of more or less common knowledge that, as years pass, changes are found in the appendices of people who have never had a clinically recognizable attack of appendicitis. How much of these changes are physiological it is impossible to decide; and in this connection it is not so important, because, whatever they are, they will interfere with the normal performance of the work of the appendix, and so lead to evil results. One of the best known of the changes is the disappearance of the lymphoid follicles that are so plentiful in early life. Is this disappearance pathological or physiological? Yet if sections are cut of appendices removed from people over sixty, or even older, these follicles sometimes can be found in abundance. The persistence in these cases may be due to individual variations in the rate of aging; or perhaps more probably, they indicate that the disappearance is of more pathological than physiological import.

In considering the physiology of the appendix, it has been shown that the cæcum is the first great place of rest or stasis for the products of digestion after they have left the stomach, consequently the appendix is a tube which serves as an index to the chemical and bacteriological processes which occurred there. One well-known property of lymphoid tissue is that its constituents are actively protective to the organism against foreign invaders. Situated in a blind tube in whose lumen are represented types of the organisms of the large bowel and their fermentations, the lymphoid follicles must have a great deal of work to do, more even than the tonsils, to which the appendix has been compared. It is well known that the tonsils undergo fibrosis or chronic inflammation without the occurrence of an acute attack. In a like manner do similar changes occur in the appendix, but unfortunately there is a very marked difference. Fibrosis of the appendix interferes with the efficiency of its peristaltic action, and the tube becomes incapable of emptying itself. By these means a vicious circle is established, as the more material (pabulum) which remains the more will bacteria flourish, and the more likely is it that the chronic inflammation will progress, and the organ become still more incapable of performing its own evacuation. Such a condition may be aptly called appendicular constipation. The inspissation of the contents will lead to the formation of an appendicular calculus of fecal concretion, which may be likened to scybala elsewhere in the large intestine. It may be assumed that the presence of concretions indicates the existence of pathological change. And their association with chronic inflammation explains the fact that they are frequently found by the surgeon and the pathologist in cases which have never had a clinically recognized attack of appendicitis.

The result of chronic appendicitis may be at times far more extensive than this. The fibrosis with its subsequent contraction leads to further disappearance of the lymphoid follicles and impairment of the muscular action. The appendix consequently becomes an inert breeding ground for micro-organisms, and if they escape into the cæcum the multiplication is continued there. The cæcum will be affected sooner or later by the continued escape into it of toxic material elaborated in the appendix, and, as it is necessary that the products of digestion remain there until they are of suitable consistency to be passed on into the ascending colon, those toxic materials will become still further elaborated and give rise to chronic typhlitis. Again there is the vicious circle, as the inflammatory condition will impair the contractile power of the cæcum, and so lead to further bacterial growth and further chronic inflammation. In this way a colitis may be established throughout the entire length of the large bowel.

# A SIMPLE METHOD OF SUTURING ALL HOLLOW VISCERA.

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A GRADUAL process of simplification during years of intestinal and stomach work finally brought me to the routine use of a method which study of the literature shows to represent in a measure the apex of a pyramid to which others have contributed the underlying strata. In reviewing the propositions which are of importance here, it is not logical, in view of what follows, that I take up the immense number of suggestions which have been made for uniting hollow viscera by methods other than those which deal with a single row of sutures embracing all coats.

The history of the continuous suture in gut work runs back much farther than many perhaps imagine. As early as 1724 Heister [1] wrote regarding it as follows:

> Wenn aber die Wunde im Darm gross ist, so ist dieselbe meinstens todtlich. Denoch weil man auch solche Patienten ohne Hülfe nicht lassen soll, so muss man dergleichen verwundte Darm ohne die Nath nicht in den Leib bringen, sondern dieselbe vorher zunahen: welches bishere durch die, so gennante Kurschners' Nath verrichtet worden, welche (Tab. viii, Fig. 10) angemahlet, reprasentiret wird. Zu dieser werden erfordet eine gemeine gerade dunne Nadelgleichen gewachster seidender oder leinener Faden.

It is not stated definitely by him whether or not he advocated perforating sutures; however, the well-known glovers' stitch of which he writes surely takes in the entire thickness of the leather, hence it is probable that Heister advocated a continuous suture which penetrated all the coats of the bowel. He quotes the work of earlier authors, which goes to show that this sort of manœuvre was known long before his time. Of course none of these very early authors appreciated the fact that serous coats must be approximated, hence their work can be regarded as of historic interest only. Still it must be admitted that such accidental approximation was probably secured in many instances because some of their patients recovered.

In 1826 Jobert [2] used a perforating interrupted suture.

In the same year, according to Jeannel,[3] Breidenbach used a suture which was apparently somewhat similar to that of Jobert, although there seems to exist a degree of uncertainty as to just where this method was published and whether or not interrupted stitches were of the variety which embraced all the coats of the bowel.

Gely [4] was the next, in 1842, to use in a long series of animal experiments a perforating suture, which, however, was of the continuous variety.

Three years later Moreau [5] advocated an interrupted perforating method in which a cuff of the mucosa was stripped out of one end of bowel into which the other was invaginated.

Vezien,[6] in 1871, wrote of using interrupted perforating stitches very similar to those of Jobert.[7]

In 1882 Nussbaum [8] advised that all intestinal sutures embracing all the coats of the bowel be of the interrupted variety and have the knot on the inside.

In 1885 Bishop [9] used perforating gut stitches. M. E. Connell,[10] in 1892, renewed the interest of the surgical world in this form of suture by publishing an oblique one-row method with a continuous suture embracing all the coats. In the same year Maunsell [11] published his unique proposition of slitting the bowel laterally, drawing the ends to be united through this slit, and sewing them together with a single interrupted row embracing all the coats. The next step was registered by Cushing,[12] in 1899, when he proposed a continuous single row which was not intended to embrace anything below the submucosa.

Popular recognition of the single row suture embracing all the coats was not, however, apparent until 1903 when F. G. Connell [13] gave to the world his method of interrupted suture. In the same year Horsley [14] published what he calls a single row over-hand continuous suture embracing all the coats. Wiggin [15] demonstrated a single row interrupted stitch with all knots inside. In 1905 Horsley[16] again wrote concerning viscera of unequal size.

The method herein advocated consists of a single row of continuous silk sutures taking in all of the viscera. No internal support is used. No special forceps or other instruments are necessary; all that is required is simple straight cambric needles and silk or other thread, as may be desired. I prefer silk, on account of its well-known physical properties, to any other suture material and use it in this way: two very fine strands of double length are carried through the eye of a Number 7 needle, then the resulting four are twisted together so that the needle remains at the end of a completed cable from which it cannot become detached. This is waxed, sterilized, and a large number held in readiness for immediate use. Four strands are used because two are not enough to make a smooth cable.

The experience of many operators has proven the single row suture anastomosis to be perfectly safe. Two or even three rows can then not guarantee more, since the rules of logic preclude the use of a comparative or superlative term that can amplify "perfectly safe." I will add that in careless or inexperienced hands more than one row might add somewhat to the safety of the operation, but this proposal is not for the beginner.

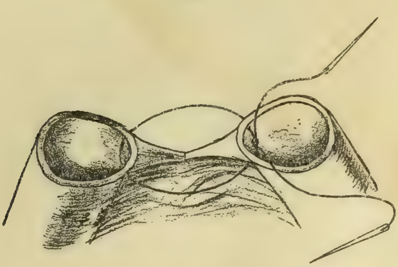
In comparing continuous and interrupted suture, all must admit that the continuous can be applied more quickly. A second advantage possessed by it is that it alone tends to hold the opposed viscera more tightly together when the tension within the lumen increases, as is likely after postoperative gas formation takes place.

Now as to the value of perforating suture. In one sense a stitch which takes in all the coats is best because it is sure to embrace the submucosa, which is the only one that offers a sure foundation. F. G. Connell proved long ago that it is practically impossible to catch submucosa many times without some of the needle holes entering the lumen of the bowel. This was done in a most ingenious manner by comparing the thickness of this layer with the diameter of the needle ordinarily used. Since it has been abundantly proven by this author as well as by others that perforating stitches are harmful in theory only, why not carry all gut needles into the lumen and thus be sure to get the firmest sort of a hold?

## END-TO-END ANASTOMOSIS.

Two threads about fourteen inches in length with a needle on each are tied together at the free ends; thus we have resulting a strand slightly over two feet in length with a needle on both ends. By referring to Fig. 1, it will be noted that the first step in the operation begins within the lumen of the gut on the left, each needle being carried out of the viscus in such a manner as to embrace the mesenteric insertion, the same being done to the mesentery of the bowel to the right as the two needles enter the lumen. These two threads are now tied together after the knot has been drawn tight and the resulting condition appears in Fig. 2. This is a most important step, since, as shown by F. G. Connell and others, it guarantees in a measure the blood supply to the part on which we are working.

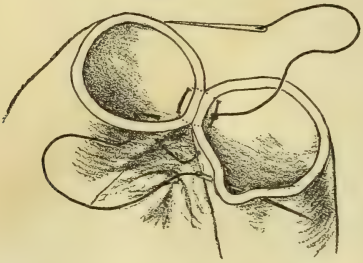
Fig. 1.



End-to-end anastomosis, first stage.

Fig. 2 illustrates the next step in the procedure. A few stitches of the continuous Connell variety are taken, all of the coats being pierced and a close approximation being secured as the thread is drawn tight. As illustrated by the needle next the reader, most of these sutures are put in by making the in-and-out excursions in one and the same motion in very much the same way that a Lembert suture is applied, the sole difference being that here all of the coats are embraced. This needle is employed for a distance of about one-third the way around the opening, when it is dropped and exactly the same manœuvre repeated in the opposite direction with the needle farthest from the reader, the single difference being that this latter needle is employed for the remaining two-thirds of the circumference or until it meets the one first used, when it will be found that the opening has been completely closed so quickly and simply as to astonish the operator. Almost all of the stitches will have been put in from the outside, and nowhere will anything but the peritoneal coat show. If the tension of the thread has been right it will be impossible to see any portion of it except the knot, which, contrary to theory, has done no harm if left exposed, although I must say that I have usually placed one Lembert suture over it for cosmetic reasons. Beginning the anastomosis at the mesentery and working away from it in both directions as described above, renders the manipulation of this important and dangerous territory much safer and easier than is the case when an ordinary continued suture which has gone clear around the gut is finished at the mesenteric insertion.

Fig. 2.

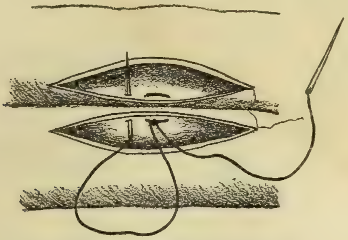


End-to-end anastomosis, second stage.

LATERAL ANASTOMOSIS.

Fig. 3 shows two loops of intestine placed side by side, with the first suture tied within one lumen, leaving the two needles ready for use. The one on the left is employed to make an ordinary running Connell suture to the left of the first knot. This is continued only until the corner is turned, when this needle is dropped and the same manœuvre carried out with its mate to the right of the first knot. The advantage of beginning in the middle to make this suture is that both the difficult corners can be turned with the whole wound wide open, which is not the case if the operator begins at either end. Now that the posterior row has been completed and drawn tight, the operator has nothing left to do but continue the anterior row, inserting the stitches in the manner shown by the needle next the operator in Fig. 2. Each thread makes half of this anterior row, the two meeting at the middle of the wound, where they are tied as shown in Fig. 4, and a simple anastomosis thus concluded. Again a Lembert suture may be superimposed if desired, although I must state that I have frequently forgotten it and the results have been just the same as where it was used.

FIG. 3.



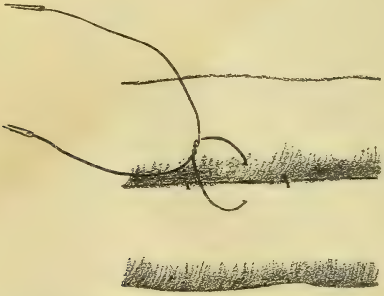
Lateral anastomosis, first stage.

### END-TO-SIDE ANASTOMOSIS.

This somewhat less common form of operation is depicted in Fig. 5, where a Roux gastro-enterostomy is in contemplation. Again we have emphasized the importance of the first silk loop which approximates the middle of the stomach wound with that portion of the small intestine which embraces the mesenteric insertion. It is scarcely necessary to dwell upon the further steps of the operation, since they are merely a combination of those given in end-to-end and lateral anastomoses. The posterior row approximates the two viscera, being inserted after the continuous Connell method, while the anterior row is again made after the manner of using the needle next the reader in Fig. 2. The resulting ends of thread are tied as in Fig. 4, and the operation is complete.

This form of suture has been found equally well applicable wherever tried and, as the following list will show, its use has met the widest possible indications in end-to-end, lateral, and end-to-side anastomoses. The stomach has been connected with the small bowel anteriorly as well as posteriorly by the lateral method as well as end-to-side in the Roux operation. Small bowel has been connected with small bowel by both the lateral and end-to-end methods. The small bowel has been united with the large bowel, not only laterally but end-to-end. The gall-bladder has been anastomosed into the stomach in one instance and in another into the large bowel. Not only has this method been used in seemingly normal viscera but on those changed by disease in almost every conceivable manner. It has proven its value in a distended gut above an acute obstruction, also in the œdematous condition associated with acute peritonitis. It has been equally successful in the compensatory thickening associated with chronic obstruction.

FIG. 4.

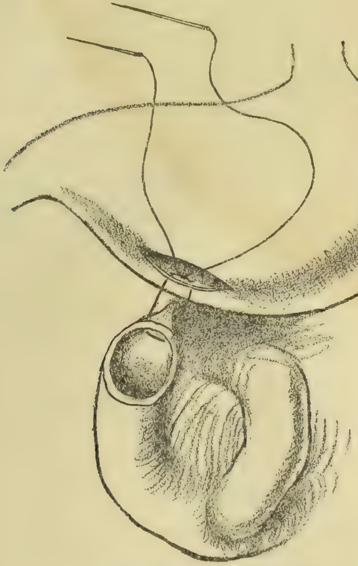


Lateral anastomosis, second stage.

After resection of the head of the ascending colon, there has been practically no difficulty in making end-to-end anastomosis between the ileum and colon of vastly different diameters. To illustrate the ease and speed with which the method can be applied, it is enough to state that a double resection with double anastomosis has been accomplished in about the same time that the single operation of this sort formerly took where complicated methods of bowel union were used. The Roux gastro-enterostomy has been frequently used in my work recently, since this simplified suture has made it possible to perform the operation in about the same time that was formerly required for a posterior gastro-enterostomy alone.

I have used this method for more than two years in every operation which I have done upon the hollow viscera of the abdomen, a very large number of cases in all.

FIG. 5.



End-to-side anastomosis.

That it is a thoroughly useful procedure, to say the least, is attested by the fact that only two of all of these patients died in the hospital of any cause, neither of them with peritoneal symptoms; one expired sixteen days after a gastrectomy and the other two days after an anastomosis between gall-bladder and stomach for the relief of biliary obstruction in cancer of the pancreas.

This method is safe, because all of the coats of a viscus are embraced and consequently every stitch has a firm foundation.

No form of suture operation could be done more quickly, because the smallest possible number of stitches and knots are employed.

No permanent ill after effects are to be anticipated, since a very scanty diaphragm is formed.

The requirements of modern surgical technic are not satisfied by any method of anastomosing hollow viscera which does not guarantee safety, rapidity, and absence of bad after-effects.

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# THE RECTOSIGMOIDAL ARTERIAL ANASTOMOSIS.

## ITS IMPORTANCE IN THE TREATMENT OF CARCINOMA HIGH IN THE RECTUM.

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It has occasionally been noted that operations by the sacral route upon carcinomas situated high in the rectum have been followed by gangrene of the bowel which has been freed to permit of the establishment of a perineal or a sacral anus. On reading the mortality rate in this field of surgery and having observed some of the unfortunate results, one is struck by the repeated report of partial or complete gangrene of the bowel in the fatal cases. It was with this point in view that this work was undertaken, with the hope that some definite idea could be obtained of a method to avoid this complication.

Quenu and Hartman were the first to open the abdomen to ligate directly the superior hemorrhoidal artery to check hemorrhage and to permit of an easier mobilization of the rectum. Hartman more recently has shown that the safe point for ligation of its superior hemorrhoidal artery is proximal to its junction with the anastomotic loop from the sigmoidal artery (Figure 1, *A*). After ligation at this point the blood passes from the sigmoidal artery through the anastomotic loop and into the rectal vascular system below the level of the ligature. Ligation of the superior hemorrhoidal artery distal to the anastomotic loop would result in gangrene of the stump, as the main vessel distal to the loop would be occluded, and the blood supply to the rectal wall cut off.

It has been demonstrated experimentally by Rubesch that the area supplied by the inferior mesenteric artery can be in-

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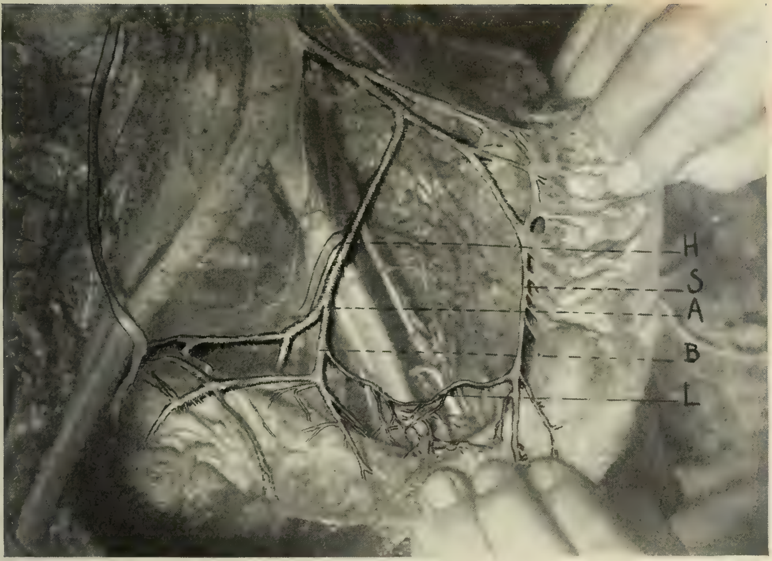
The author wishes to express his appreciation of the kindness of Drs. Bensley and Harvey for their assistance and for the use of their dissecting room material.

jected through the superior mesenteric artery after ligation of the former. This observation can only be regarded as an interesting anatomical fact, for clinically a collateral circulation is not provided rapidly enough after ligation of the inferior mesenteric artery to prevent gangrene, even if the branches of the artery are not to be regarded as terminal arteries. Sudeck was the first to emphasize the necessity of an abdominal incision to determine the exact location of this anastomosis, which he names the " critical point."

Variations in the rectosigmoidal anastomosis are common. With the view of determining the frequency and nature of these variations, and the relation of the vessels entering the anastomosis to the bowel wall and to each other, I have examined 21 subjects. The vessels had been injected with a starch mass containing lead oxide. In some cases the vessels were dissected out to the bowel wall, while in others the relationship of the vascular loop was determined by X-ray pictures. Reproductions of some of these accompany the text.

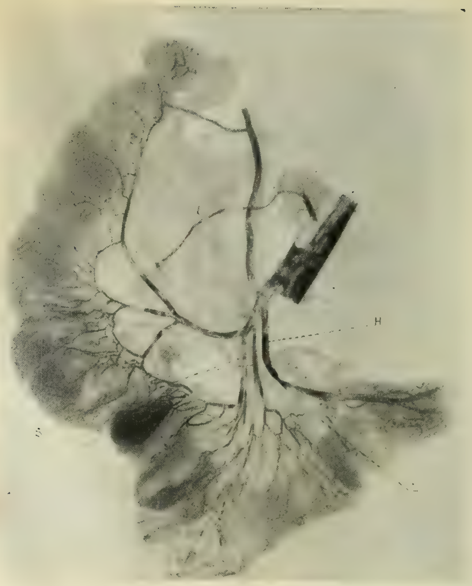
Three of the subjects were females. These showed no variations which can be considered peculiar to the sex. A definite, well-developed loop was absent in two cases (Fig. 2). In these instances ligation of the superior hemorrhoidal artery at any point would have resulted in gangrene, as the vascular anastomosis within the wall of the bowel would not furnish enough blood. After resection of the rectum for a high lying carcinoma in such cases, it would be safest to draw the proximal end of the rectum or sigmoid out through the abdominal wall and form an iliac anus. The loop varied in calibre from an artery as large as the vessels it connected to a mere thread-like vessel in one instance. The loop was found on an average 1.5 cm. below the level of the promontory of the sacrum (Fig. 1). In one subject, however, the loop was found 5 cm. below the promontory. The anastomosis was found at a varying distance from the bowel. The rule of clamping the vessels as far back from the rectum as possible, to avoid injury to the blood supply when operating by the sacral route, results in missing the loop where it lies close to the bowel, as in Figs.

FIG. 1.



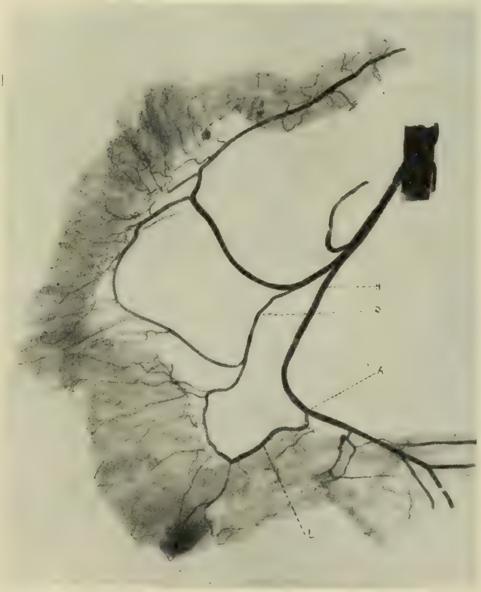
*A*, critical point; *B*, too low to supply entire rectal system; *S*, sigmoid; *H*, sup. hem. artery; *L*, loop anastomosing with sup. hem. artery below bifurcation.

FIG. 2.



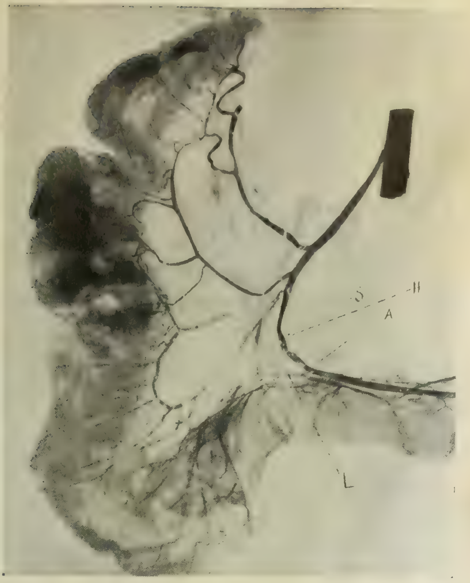
*S*, sigmoidal arteries; *H*, sup. hem. artery; *L*, no well-developed loop present.

FIG. 3.



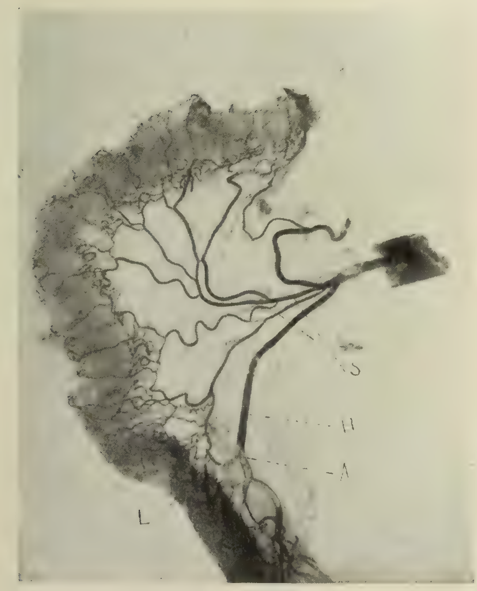
*A*, critical point; *S*, sigmoidal artery; *H*, sup. hem. artery; *L*, loop lies close to bowel.

FIG. 4.



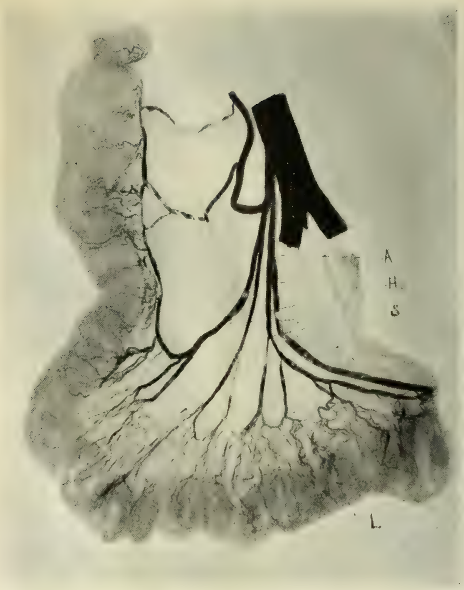
*A*, critical point; *S*, sigmoidal artery; *H*, sup. hem. artery; *L*, loop close to bowel.

FIG. 5.



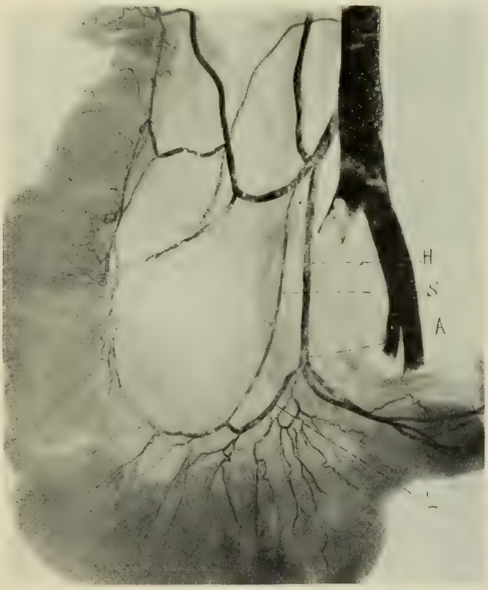
*A*, critical point; *S*, sigmoidal arteries; *H*, sup. hem. artery; *L*, loop close to bowel.

FIG. 6.



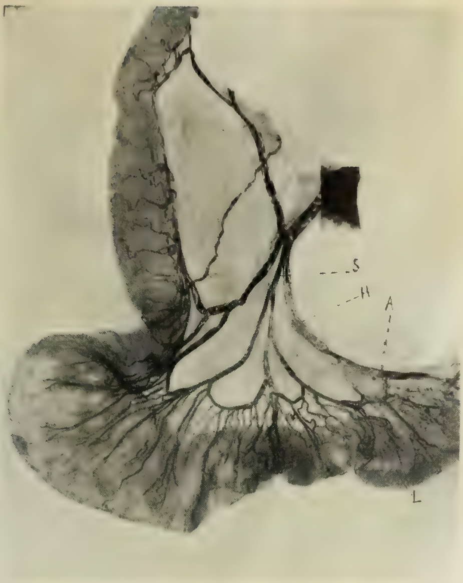
*A*, critical point; *S*, sigmoidal vessels; *H*, sup. hem. arteries, bifurcation proximal to anastomosis; *L*, loops double, distant from bowel.

FIG. 7.



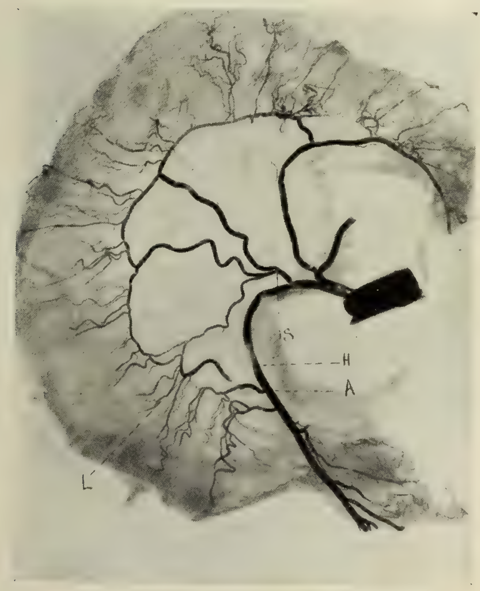
*A*, critical point; *S*, sigmoidal artery; *H*, sup. hem. artery; *L*, loop.

Fig. 8.



*A*, critical point; *S*, sigmoidal artery; *H*, sup. hem. arteries; *L*, double loop.

Fig. 9.



*A*, critical point; *S*, sigmoidal artery; *H*, sup. hem. artery; *L*, loop.

3, 4, and 5. With relations as shown in Fig. 6, on the other hand, there would be great danger of catching some portion of the loop, because it arises so far from the bowel. After occlusion of the vessels, gangrene of the stump occurs in greater or less extent, the fæces escape into the wound, and if infection reaches the peritoneal cavity the patient dies of peritonitis.

In several instances the bifurcation of the superior hemorrhoidal artery occurred before the sigmoidal loop joined the rectal supply (Figs. 1 and 5). In most of these cases the sigmoidal branch joined with the upper division of the hemorrhoidal artery; in two cases, however, it anastomosed with the lower division. In these instances ligation immediately above the junction of the sigmoidal loop (Fig. 1, *B*) would be dangerous, and ligation should be performed above the point of division of the superior hemorrhoidal artery at *A* in Fig. 1. This division of the superior hemorrhoidal artery is variable as shown in Figs. 4 and 5, the length of the main artery varying from 2 cm. in Figs. 1 and 5 to 6 cm. in Fig. 7. In some instances this artery passes down as a single trunk from the inferior mesenteric artery to its subdivision upon the rectum (Figs. 4, 8, and 9).

Section of the superior hemorrhoidal artery above would permit of mobilization of a considerable length of the sigmoid (Figs. 1, 3, and 9). With a condition as shown in Fig. 7, section of the hemorrhoidal artery and the small division of the sigmoidal artery would give ample movement to the sigmoid colon; but with a vascular system as pictured in Figs. 2, 4, 6, 7, and 8, several large trunks would have to be sacrificed to obtain any marked descent of the sigmoid.

## CONCLUSIONS.

Total twenty-one subjects: loop present in 19 cases; superior hemorrhoidal artery bifurcated before junction with loop, 7 cases; loop anastomosed with lower division, 2 cases.

Lowest loop was found in one subject with the critical point almost in bottom of cul-de-sac of Douglas. Vast majority of other cases were found about 1.5 cm. beneath the promontory of the sacrum.

Sixteen subjects showed the loop close to the bowel.

Five subjects showed the anastomosis formed by large loops at a distance from the bowel.

1. Following high resection of the rectum, gangrene of the stump can be avoided by ligation of the superior hemorrhoidal artery proximal to the point of entrance of the anastomotic loop from the sigmoidal artery.

2. Where high resection of the rectum is to be done by the sacral route, a preliminary abdominal incision is of value to determine the presence and location of the critical point, the relations of the superior hemorrhoidal artery, and permits of a definite placing of ligatures to check hemorrhage.

3. The anastomotic loop is not present in some cases. High resection of the rectum for carcinoma in these cases should be terminated with a permanent colostomy.

The X-ray pictures are printed as viewed from behind.

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# THE BONE METASTASES OF HYPERNEPHROMA.

## A COMPLETED RECORD OF A CASE WITH SOLITARY BONE METASTASIS.

BY CHARLES L. SCUDDER, M.D.,

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Surgeon to the Massachusetts General Hospital; Lecturer on Surgery, Harvard Medical School.

In the ANNALS OF SURGERY for December, 1906, p. 851, I published the report of certain cases of hypernephroma occurring at the Massachusetts General Hospital clinic. One of these cases was reported in considerable detail. I wish here to complete the report of this case, numbered XI in the former paper.

The facts of interest in connection with this particular case are as follows: It was thought previous to operation that this man had a sarcoma of the upper end of the shaft of the right humerus (Fig. 1). An amputation at the shoulder-joint was done (Fig. 2). The microscopic examination of the removed tumor demonstrated that it was a hypernephroma (Figs. 3 and 4). Before the patient recovered from the anæsthetic, careful palpation of both kidneys discovered a slight enlargement of the left kidney. He had had no pain in the side and no hæmaturia. During the casual inspection in the routine ward examination this slight enlargement of the left kidney was not detected previous to operation.

Certain questions of practical importance arose at that time, namely: What is the proper attitude toward the kidney tumor as yet manifesting no symptoms? Shall it be removed? If removed what will be the prognosis? In this particular case the diagnosis of hypernephroma was made first from an examination of a metastasis. The metastasis first suggested the presence of a hypernephroma. The very great proneness of the hypernephromata to metastasize as demonstrated by autopsy reports and the fact that the metastases are usually multiple would lead one to give an unfavorable prognosis in this particular case, even after nephrectomy, were it not for a series of very careful observations by Albrecht[1] from Hochenegg's clinic in Vienna, to the effect that there may exist a solitary hypernephroma metastasis in bone. In this Case XI of my series, it was thought possible that this bone metastasis, which had been removed by amputation, might be the only metastasis in the body.

The feeling with regard to this case at the time of the operation was that a chance for the man's life lay in a nephrectomy, but that this would be efficacious only if there were no other metastases in the body. Nephrectomy was urged upon this man but he constantly refused operation.

In January, 1910, a little less than five years after operation, he died, wasting away as if with some blood disease. It was possible to make a complete autopsy with the exception of an examination of the spinal cord. The cranial cavity, thorax, and abdomen were thoroughly examined. There had been no return of the trouble locally at the seat of the original operation. The left kidney was as large as two adult fists. The accompanying photograph (Fig. 5) shows the relation of the tumor to the kidney itself. The pathological report upon the tumor made by Dr. Oscar Richardson is appended. No metastases were found in any part of the body. The man had had no symptoms, so far as is known, from the kidney tumor.

This case, then, first reported in the ANNALS OF SURGERY for 1906, is now rendered complete by autopsy. This case adds one more bit of evidence to the two cases from Hochenegg's clinic illustrating the fact that one bone metastasis may be the sole metastasis present in the body. Had a nephrectomy been done soon after the operation for removal of the upper extremity containing the metastatic focus, the man's life would have been prolonged.

Report of microscopical examination of hardened and stained sections from a tumor of the kidney, Case XI, Series Massachusetts General Hospital Hypernephromata, April 7, 1910:

The sections all show a distinct meshwork of capillaries between and along which rest irregular columns and small masses of rather large epithelial-like cells with a rather well-marked eosin staining granular protoplasm in places, but showing elsewhere rather generally a thin vacuolated, faintly staining protoplasm. The nuclei are rather large,

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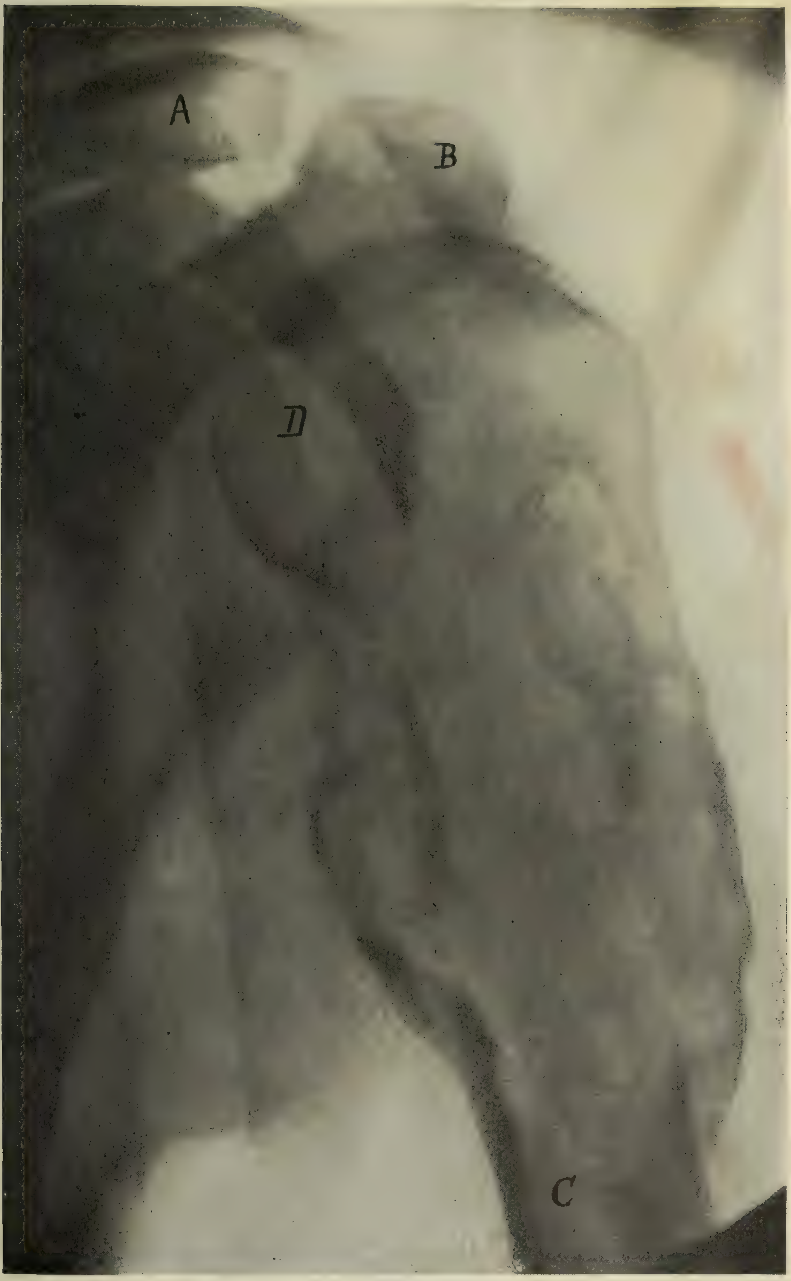
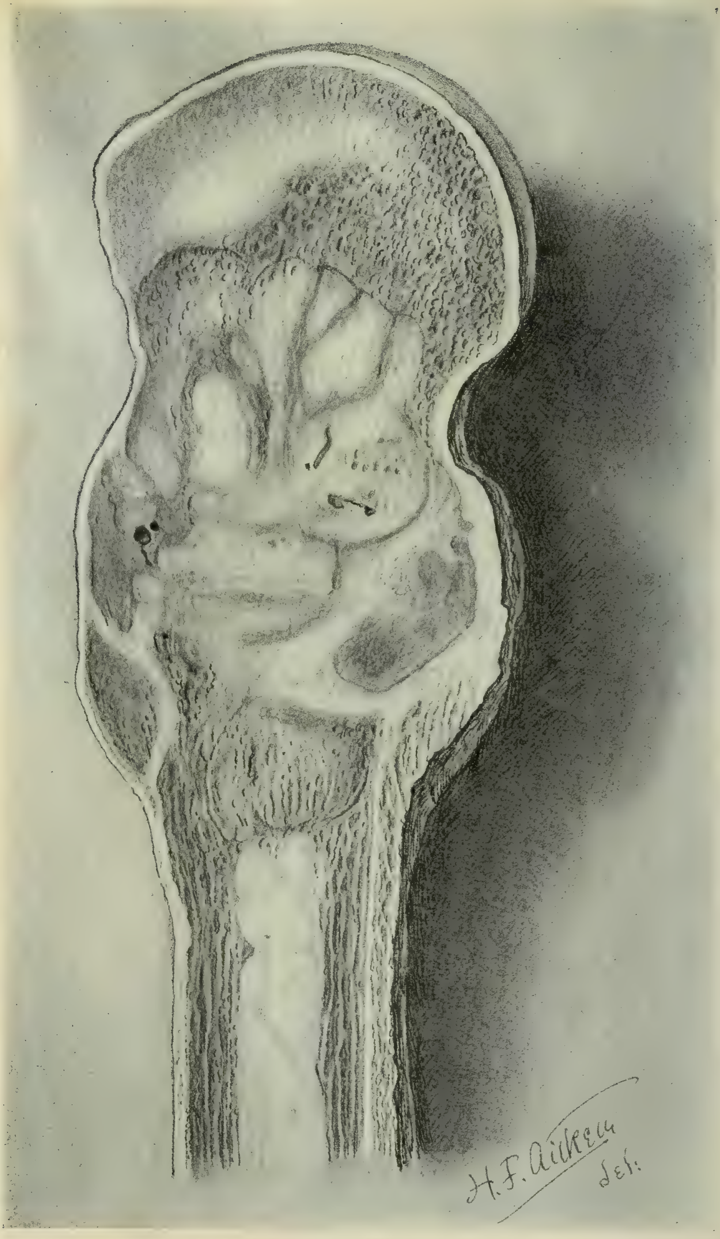
[1] Arch. f. klin. Chir., 1905, lxxvii, 1073.

FIG. 1.



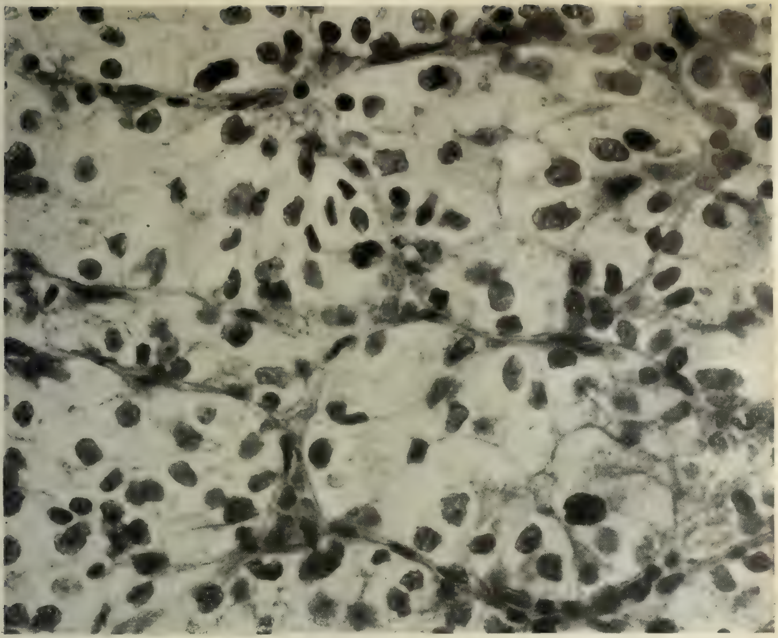
X-ray of upper end of humerus, showing region of tumor, *D*, *C*. *A*, clavicle; *B*, acromion; *C*, shaft of humerus; *D*, head of humerus.

FIG. 2.



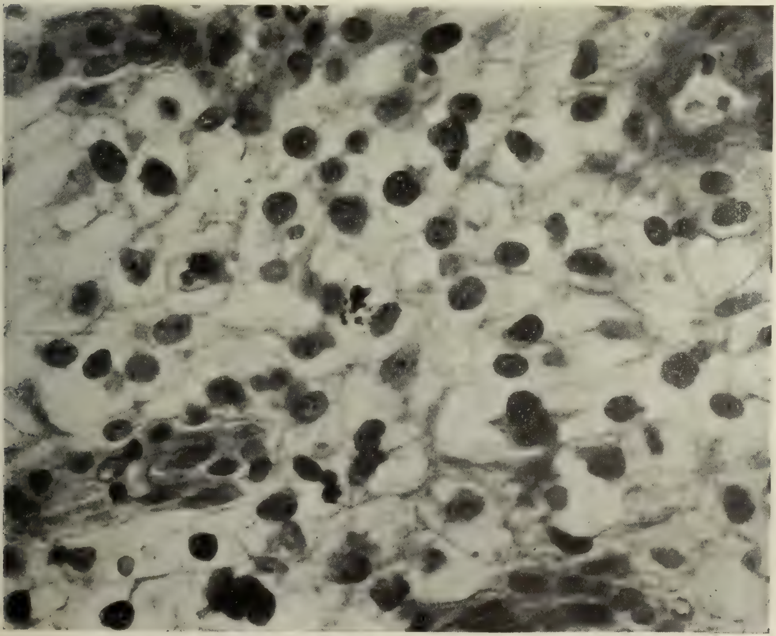
Hypernephroma, metastatic, in upper end of the shaft of the right humerus. Drawing made from a section of the gross specimen.

FIG. 3.



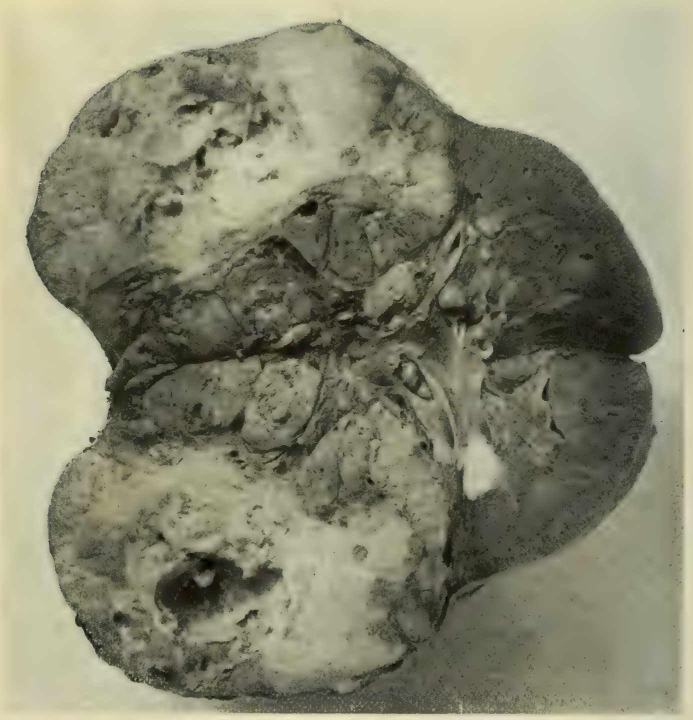
Microphotograph of a section from metastatic hypernephroma in upper end of humerus. Oval polygonal cells—preservation of rim of cytoplasm, deeply staining nucleus, perinuclear lightly staining spaces. Microphotograph by Mr. Brown, M. G. H. Laboratory.

FIG. 4.



Microphotograph of a section from metastatic hypernephroma in upper end of humerus. Higher power than in previous plate, Fig. 3.

Fig. 5.



Hypernephroma of kidney of Case XI removed at autopsy. The kidney and tumor have been split. Each half of the section is shown in the photograph. The photograph was by Mr. Brown of the Pathological Laboratory of the Massachusetts General Hospital. See pathological report.

well defined, and show well-marked chromatin granules. In instances nucleolus-like masses are seen. The protoplasm of the cells which are arranged along the walls of the capillaries rests in close association with the wall of the capillaries. This arrangement of cells and capillaries resembles quite a little the structure of the cortex of the adrenal gland. In many places there are coarse trabeculæ of connective tissue from which finer prolongations extend in among the capillary network. Here and there in the midst of the connective tissue there are collections of small round cells. The peripheral cells of some of the small masses of tumor cells are arranged around and along the walls of the capillaries in such a fashion that roughly they present a tubular formation. In many places the tumor sections show well-marked areas of necrosis. At other points the capillary walls surround large oval spaces with comparatively few atrophic degenerated looking cells resting along the walls of the capillary meshwork.

Diagnosis: Hypernephroma.

(Signed) O. RICHARDSON, *Assistant Pathologist, Mass. General Hospital.*

# PLASTIC REPAIR OF THE THUMB.

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OF NEW YORK,

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Medical College; Visiting Surgeon to the Harlem and the New
York Red Cross Hospitals.

THE case embodied in this report possesses interest because of the fact that the patient came under the observation of the writer after the decision to amputate the afflicted thumb had been reached, and because the measures employed eventually made preservation of a useful member possible. It is also regarded as worthy of record on the ground that the thumb is, as is well known, " half a hand," and its removal entails considerable loss of function and consequent lessening of the earning capacity of one concerned in doing manual labor for a livelihood.

Miss X., aged fifteen, came under observation December 4, 1909. The history obtained at that time was that three months previously she had broken off a cambric needle in the left thumb near the interphalangeal joint. This was removed under local anæsthesia. Several days later the thumb became painful and swollen, and evidently was quite acutely infected. This was treated with a wet carbolic acid dressing which resulted in a carbolic acid gangrene.

The consequent sloughs separated very slowly, and at the end of three months the thumb appeared as shown in Fig. 1. The distal phalanx is contracted, the interphalangeal joint is ankylosed, and the area of granulation shown had not undergone any change in size for several weeks. It was believed that the infection had invaded the joint and exfoliation of bone had taken place. A radiograph (Fig. 2) showed this to be true. It will be seen that the joint surfaces are quite effaced and that some of the phalanges themselves have separated. The extent of bone disease is best recognized by comparing the radiograph of the afflicted thumb with that of the other normal thumb contiguous to it.

It was deemed proper to make an effort to save the thumb, and it was believed that an ankylosed interphalangeal joint was less objectionable than would obtain were an amputation at the metacarpal phalangeal articulation performed. The indication seemed to be to excise the granulating area of soft tissues, remove what dead bone was still existing, and make plastic repair of the denuded area.

Accordingly, on December 6, 1909, the technic was carried out in the following way: The entire granulating surface, together with the contiguous scar tissue, was excised. Only a very small sequestrum was found, and this was removed with the Volkmann spoon. The joint cavity itself was filled with new bone which was only slightly disturbed in removing the sequestrum. A bridge flap was now fashioned at the anterolateral aspect of the thigh. Its conformation and application to the denuded area on the thumb are quite well shown in Fig. 3. This site was selected for the purpose after considerable experimentation with the thumbs of the writer and his assistants. The reader is asked to place his own thumb in position to allow of its dorsal aspect being placed in the relationship shown in the picture (Fig. 3) on a portion of the body without twisting the wrist-joint and thus making tension on the flap. It will be found that the one selected in the case reported is perhaps the only one available for the purpose, except perhaps the pectoral region on the side of the body opposite to the thumb used. The latter site would not be objectionable in the male, however in females it is fair to assume that this region is regarded as offering certain allure to the opposite sex which the scarring following an operation of this sort would be likely to destroy.

The bridge flap consisted of skin only. The subcutaneous fat was left attached to the fascia lata, making a bed for the palmar surface of the thumb to rest upon.

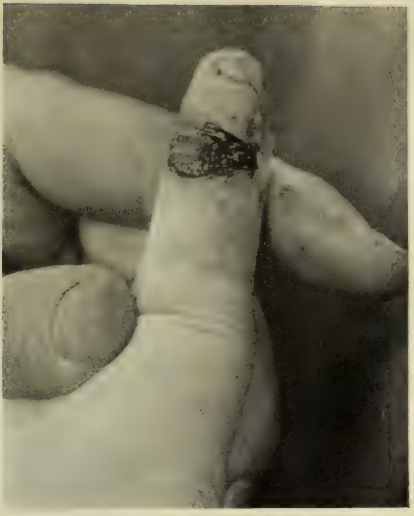
The edge of the flap toward the wrist was fastened in place with three interrupted silkworm gut sutures introduced with a small Hagedorn needle. The distal edge of the flap was attached by a single silkworm gut suture. The latter step was precautionary, as no doubt the introduction of several sutures in this situation would have traumatized unwarrantably the already badly nourished distal portion of the part.

December 10 (four days after the operation), one-half of the lower portion of the flap was sectioned with scissors. The edge of the wound on the thumb side bled quite freely, showing that the circulation was maintained at this time.

At this time the edge of the wound in contact with the thumb showed a slight reactionary inflammation. There was no evidence of infection, however, and the patient's general condition was very satisfactory. The entire arm, hand, and thigh had been immobilized at the time of the operation, using adhesive plaster straps for the purpose. Of course considerable annoyance was caused the patient by the strained position she occupied, and especially was it difficult to take care of the urine and fæces without disturbing the parts concerned in the repair. The latter consideration would not be so important a factor had it been feasible to use a portion of the trunk for the purpose, as then immobilization of the parts would have been much simplified. Due consideration should be shown this aspect of the situation in cases where plastic repair is attempted; however in this case it would seem that the method employed was justified.

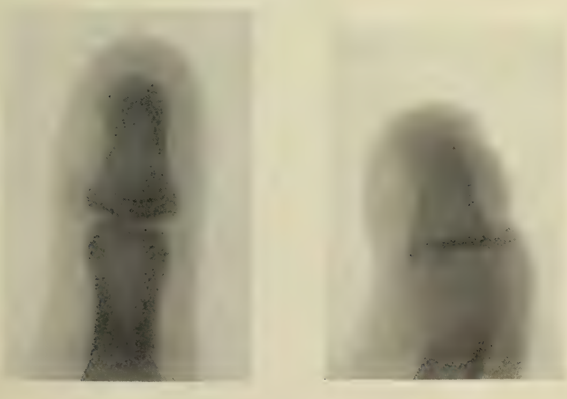
December 12 (six days after the primary operation and two days after partial section of the lower portion of the flap), the upper portion was sectioned to the extent of one-half its breadth. The second section was made at the side of the bridge flap opposite to the one made two days before, in the lower portion of the flap. This was done in this manner to conserve circulation from the widest possible contiguous areas. At this time there was some odor emanating from the wound; however this was found to be due to secretion and not, as was at first feared, to sloughing. When the upper section was made, bleeding occurred from both the thumb and the thigh sides of the incision, showing that circulation was quite maintained in the flap. The distal end of the thumb was quite buried in granulating tissue, which had grown up from the thigh wound as will be seen in Fig. 4. There was but a meagre portion of the thumb protruding from that side of the flap at the operation (Fig. 3), and its burial in granulation tissue is not to be wondered at. Fig. 4 shows the condition of affairs at this dressing. The lower wound where the flap was first partially sectioned had begun to granulate at this time. The upper section shows more plainly, being freshly made a few minutes before the

FIG. 1.



Appearance of thumb three months after carbolic acid gangrene.

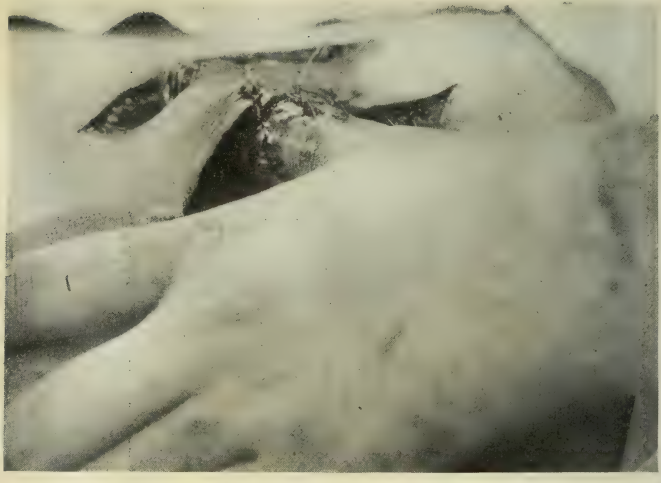
FIG. 2.



Sound thumb. Affected thumb.

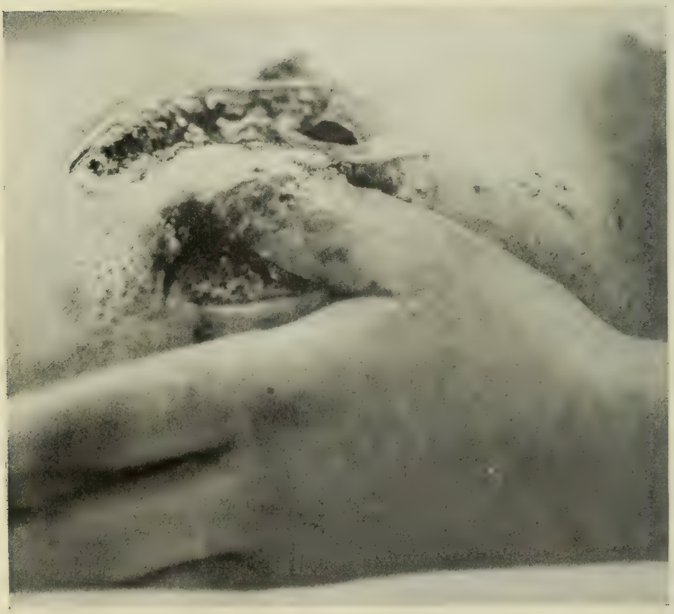
Radiographs of afflicted thumb and sound thumb.

Fig. 3.



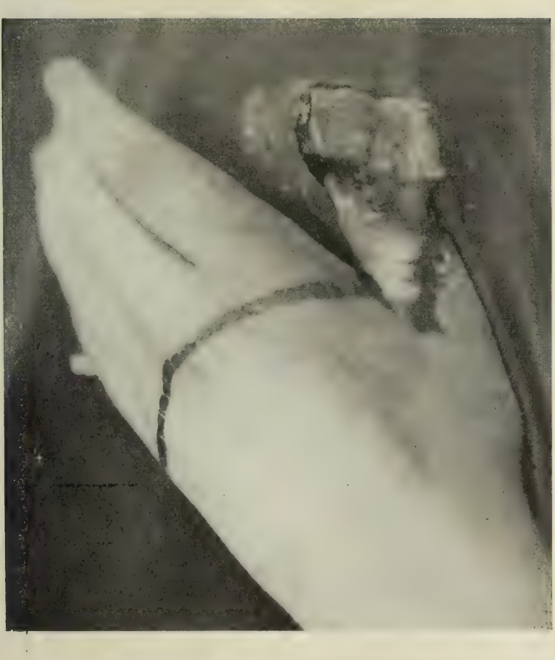
Bridge flap on anterolateral aspect of thigh. Thumb fastened to flap with silkworm gut sutures.

Fig. 4.



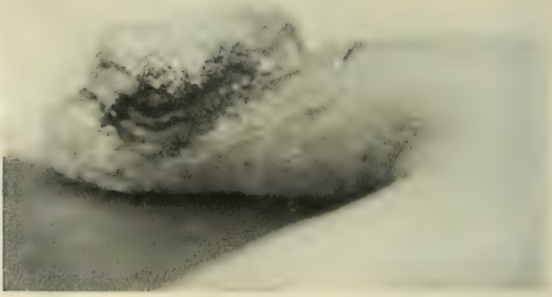
One-half of either margin of bridge flap sectioned. The section to the left already beginning to granulate. Upper (right) section freshly made. Distal end of thumb buried in granulation tissue.

Fig. 5.



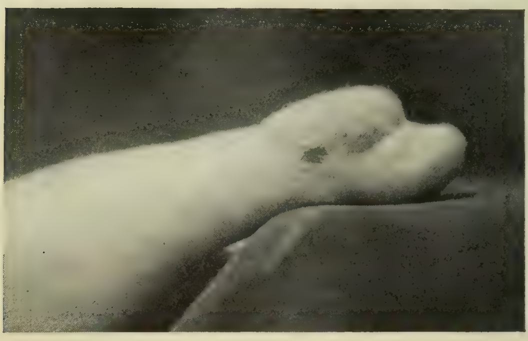
Appearance of thumb immediately following complete dissociation from thigh. Streak of blood from edges of flap showing that nutrition is maintained.

FIG. 6.



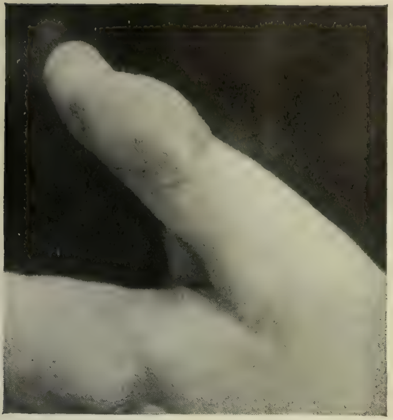
Lateral view of thumb nine days after release from thigh. Note contraction and adaptation of graft.

FIG. 7.



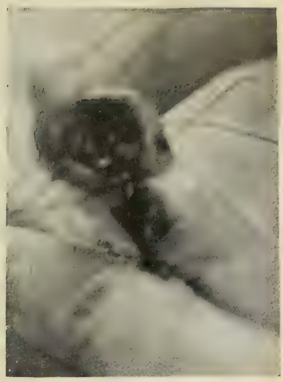
Lateral view of thumb two months after operation showing farther contraction of graft.

Fig. 8.



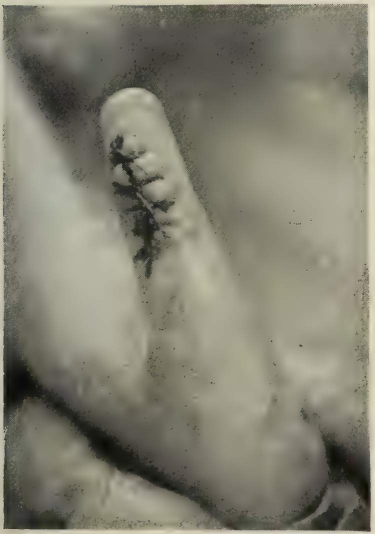
Same as Fig. 7 (two months after operation). Dorsal view.

Fig. 9



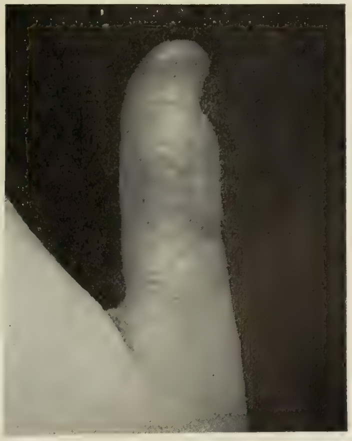
Elliptical portion of dome of graft excised. Interrupted silkworm gut sutures inserted.

Fig. 10.



Sutures shown in Fig. 9 tied

Fig. 11.



Ultimate result (about five months after original operation).

photograph was taken. One of the sutures at the wrist side of the flap was removed at this time. On the whole the conditions were favorable, yet there was an abundant amount of secretion which, as already stated, had some odor. Ordinarily the presence of odor may be regarded as of unfavorable prognostic import in plastic cases, though in this case it proved not to be so.

December 14 (eight days after the operation), the flap was entirely sectioned and the thumb released from the thigh. Fig. 5 shows the condition at this time. The flap is seen to extend to a considerable degree beyond the edges of the thumb itself. However the space beneath it is filled with granulation tissue, and if healing progressed we had a right to expect much contraction at both edges of the flap. The edges of the flap bled freely. Indeed a streak of blood is seen in the illustration (Fig. 5) flowing from the thumb across the dorsal side of the hand. This argued well for a successful outcome.

The thigh wound was dressed in the usual way, but the thumb was enveloped in a wet saline dressing. The presence of odor would suggest the employment of antiseptics; however we felt that the nutrition of the parts was best conserved by the use of the sterile saline solution.

December 23 (17 days after the operation and nine days after release of the thumb from the thigh), the conditions present were those shown in Fig. 6. This is a lateral view of the thumb. In front little of the nail is seen. At the sides repair is slowly going on. At each dressing following release of the thumb from the thigh, a small slough formed at the edges of the flap which was each time cut away. This slough formation was no doubt due to the fact that a small area of flap did not receive sufficient nutrition to maintain it.

At this time the thumb did not present a very symmetrical appearance. The thumb is shown in this rather unfavorable condition to act as a guide in similar cases, where unnecessary disappointment might be felt by the patient at its appearance, since, as is shown later on, marked improvement occurs in the end.

February 6, 1910 (two months after the operation), the thumb appeared as shown in Fig. 7. Comparing this to Fig. 6, it will be seen that a marked contraction of the grafted tissue has taken place, and this as the outcome of natural adaptation and not due to any treatment. The thumb is, however, not to be regarded as one likely to inspire sculptors to ecstasy.

Fig. 8 shows the thumb from its dorsal aspect, the photograph being taken at the same time as that shown in Fig. 7. This illustration (Fig. 8) shows some fine hair growing on the flap, which is also objectionable from a cosmetic stand-point.

February 23, 1910 (ten weeks after the original operation), the dome of the flap was excised by removing an elliptical portion as shown in Fig. 9. The parts bled freely, showing that new blood-vessels had developed in the grafted tissues. The thickened portion was composed of dense connective tissue which was excised to some extent beyond the edges of the superficial incision, with the view of thinning out the graft. Five horsehair interrupted sutures were introduced and when tied the part appeared as shown in Fig. 10.

Fig. 11 shows the condition of the thumb on May 10, 1910 (about five months after the original operation and about three months after the last operation). The ultimate result is an ankylosed interphalangeal joint, a not particularly offensive looking thumb and one which is useful in the performance of most necessary manipulations of ordinary life.

The report of the case is gone into thus in detail with the view of aiding the reader in formulating a method of repair in similar cases. Last but not least, attention is called to the fact that the original affliction was no doubt greatly contributed to by the use of carbolic acid used over a considerable period of time, a measure of doubtful utility at best and always liable to result in some such condition as obtained in this instance.

# WRIGHT'S SOLUTION OF SODIUM CITRATE AND SODIUM CHLORIDE FOR DRAINAGE.*

**BY L. R. G. CRANDON, M.D.,**

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One of the most rational and efficient therapeutic measures that has been offered in the treatment of localized infection is the solution of sodium citrate and sodium chloride devised by Sir Almroth E. Wright. This solution is composed of sodium chloride 4 per cent. and sodium citrate 1 per cent. in water.

## THEORY.

Surgeons for years now have railed against wicks, wicks which do not drain. A wick in a few hours becomes clogged with the coagulation of blood, lymph, and pus, and becomes more of a plug than a drain. Removal of such a wick twelve to twenty-four hours after its insertion is frequently followed by a gush of retained pus. Coagulation and crust formation are the foes of good drainage and have led to the expressions, " Let your drainage be efficient," " Make a surgical incision," and " Whatever you do, do not make a *medical* incision." Nature's way of draining an abscess through a small hole is for all reasons the best if the free flow of pus can be maintained.

The essential factor to limit or to begin the " cure " of an abscess is free bathing of the bacteria in the walls of the cavity with fresh serum from the blood, with its high antitrophic power. If such a free bathing of serum can be made continuous without introducing hemorrhage or causing injury to the tissue, here indeed would be for the first time a rational method of dealing with localized infection.

Wright's salt and citrate solution seems to fulfil these requirements. Sodium citrate (1 per cent.) in the solution causes a precipitation of calcium salts in the lymph, removing thereby that which is essential to coagulation. The presence, then, of the sodium citrate in the wound cavity ensures a comparatively free exit of the lymph discharge. The sodium chloride, in hypertonic solution (4 per cent.), by osmosis brings about a flow of lymph through the walls of the cavity, the sodium citrate having dissolved clot and prevented further coagulation. Thus there is brought about a continuous pouring forth of lymph of high antitrophic power from the blood stream and lymph spaces, through the walls of the abscess cavity and out through the wound. The 4 per cent. solution is in itself antiseptic since bacteria will not grow in it.

## PRACTICE.

To Sanborn of Boston is due the introduction of Wright's solution into our practice.

Conclusive evidence that the salt and citrate solution as a dressing and irrigation contributes to the destruction of bacteria in the walls of the abscess cavity has been, and may be at any time, obtained in the laboratory.

A patient came to the clinic for treatment of an infected wound of the thumb, the result of operation for a streptococcus infection on the previous day. When first seen, in the wound was a thick coagulated mass of pus and lymph, which obstructed all flow. The patient had a temperature and the local condition showed swelling, tenderness, and was the cause of much pain. In order to test as to whether the phagocytic activity beneath this crust was at all efficient, the crust was removed and smears were made from the fluid expressed at the base of the wound. It was found that most of the phagocytes were disintegrated, but that some appeared to be normal. It was only in the rarest instances that the streptococci were to be demonstrated within a leucocyte, but, on the contrary, there was a profusion of streptococci growing in long chains outside the phagocytes. The patient was given a small inoculation of vaccine, and a dressing of sodium citrate and sodium chloride was applied to the wound. The patient was told to soak the thumb one hour out of four until the next day, and between times to apply hot poultices of the same solution to the lesion.

On the following day, macroscopically, there was an entirely different picture. The thumb was less red; there was free discharge and an absence of crust. The temperature was normal. A smear from the lymph, expressed in the same manner from the depths of the cavity, showed a striking difference from that seen on the previous day. No broken-down leucocytes were to be seen. In practically all the leucocytes were found many inclusions of streptococci in pairs and in short chains, while outside the leucocytes there were no long chains to be seen and cocci were only occasionally found.

## TECHNIC.

The abscess is opened by a wound as small as will allow the cavity to be wiped out, or thoroughly emptied by expression. The skin round the wound is thoroughly cleaned with 70 per cent. alcohol. The skin in this region, up to the very mouth of the wound, is smeared with boric acid or eucalyptus vaseline. If the skin tension closes the lips of the wound a bit of rubber dam may be put in. The wound is covered with a voluminous pad of gauze or of absorbent cotton covered with gauze, dripping wet with hot salt and citrate solution. A many-tailed bandage or some other application holds the poultice in position and the part is put at rest. Outside the dressing may be applied a hot flax-seed poultice or a hot-water bottle. In any case, as often as the dressing gets cold more of the hot solution is poured over the whole dressing to wet and warm it again, or the dressing is removed and the whole part is soaked, if possible, or bathed with the same solution.

## PRECAUTIONS.

The amount of sodium chloride in this solution is such that it will irritate the skin and lead to pustulation in a few days. Hence the frequent application of protective vaseline to the unbroken surrounding skin.

This solution is contraindicated if there is a tendency to persistent oozing of blood from the wound. It is also contraindicated where the formation of protective adhesions is desirable, as in certain abdominal wounds just after operation.

The solution should be used only for the first 36 to 72 hours after operation, during the acute stage of the inflammation. If longer used it leads to maceration and indolence in healing.

Two years of experience has amply proved the value of this solution. In office practice an abscess is opened, a small piece of rubber dam is inserted or not, a dressing with the inner layers wet with glycerin applied, and the patient is then given a recipe for one or more ounces of sodium citrate. He is told to go home, to add to a glass (eight ounces) of hot water about two and one-half teaspoonfuls of common salt and a large teaspoonful of the sodium citrate. With this solution he is to keep the dressing on his septic wound constantly wet and warm. Inguinal and axillary bubo, abscess of neck, septic fingers, mastoid wounds, otitis media after paracentesis, all drain most efficiently under this method. At the end of 36 to 72 hours the wound is filled with glycerin or balsam of Peru and is ready to heal.

# THE RELATION OF THE DUCTLESS GLANDS TO SURGERY.*

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THE relation of any given subject to surgery is primarily and always—in the broad sense—precisely the same as the relation of that subject to the fundamental field of the philosophy of medicine. There are certain things, however, which bear a more particular relationship to some one or other of the various special branches; among those fields in which surgery should be especially interested is the problem of the function and the pathology of the ductless glands.

The problem bears a threefold relation to surgery. In the first place, the surgeon is often specifically concerned with the treatment of the pathological conditions occurring in these glands. A mere enumeration of these structures will suggest many such instances, like acromegaly and exophthalmic goitre; this physiologic group comprises the hypophysis and perhaps the pineal in the brain; the thyroid, parathyroid, and carotid gland in the neck; the thymus in the chest; the spleen and the adrenals in the abdomen; the lymphatic system. There are also certain ganglion-like structures in various parts of the body, belonging to the sympathetic nervous system, and grouped together as the chromaffine system. In addition to the true ductless glands, many, if not all, organs with distinct ducts have also an internal secretion which may be even more important than the external secretion; the internal secretion of the liver is of far greater importance than its external secretion of bile.

In the second place, the surgeon should have a special interest in all these glands of internal secretion, because it often requires a mastery of surgical technic to make possible an approach to the study of their function. An excellent example of this is the recent work of Cushing on the pituitary gland. Or, again, because of a surgeon's familiarity with the pathological picture, he may have acquired a peculiar position of authority in the study of the etiology of these conditions: an example of this is the work of Bircher on the etiology of goitre.[1]

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* Read before the Philadelphia Academy of Surgery, April 25, 1910.

The last element in this threefold relation of these structures to surgery is the one to which I would especially call attention, a relation which, it seems possible, may exist in the practice of general surgery. I refer to the relation of that group of structures known as the "chromaffine" system to the blood-vascular apparatus, and specifically to blood-pressure. The term "chromaffine" is derived from the presence of certain cells which possess a peculiar affinity for the salts of chromic acid; in the case of the adrenals, it is considered satisfactorily demonstrated that these cells are the ones which contain the pressor substance characteristic of the gland. The chromaffinity of these cells is therefore taken as the index of the functional state of the gland, although a fair doubt of the correctness of this assumption may be entertained.

It is not within the scope of this paper to enter into a discussion of blood-pressure, because it is such a complicated problem that it cannot be handled at all unless exhaustively. For the purpose of the present argument, we will therefore leave out of consideration all the factors concerned in blood-pressure except three, which three, it so happens, are also the factors which must probably be most important in a given space of time, such as a surgical operation. These factors are: first, the vasomotor centres in the brain and cord; second, the paths along which the power generated in the centres is transmitted, the vasomotor nerves; and, third, the mechanism by which the power generated in the centres, and transmitted by the nerves, accomplishes work.

For our present purpose we may define blood-pressure as the result of an opposing of a resistance to the force of the heart-beat; variations of pressure are brought about by varying this resistance. It is generally held by physiologists that the chief resistance to the blood flow is offered by the arterioles and not by the capillaries: changes in the calibre of the arterioles will greatly vary the resistance, and therefore the blood-pressure. These changes of calibre are made possible by the coat of smooth muscle-fibres which surrounds the arterioles. These muscle-cells are in a condition of semicontraction known as " tone," and they are kept in this state by factors entirely apart from the nerve-centres of the brain or cord.

If I may be pardoned a homely simile in order to make my point of view perfectly clear,—no matter how perfect the construction of the engine, no matter how correct the system for the transmission of power, the engine will probably saw no wood if there be no saw for it to turn; and if a saw be present the total efficiency will depend as much upon the condition of the saw as upon the perfection of the engine. To transfer these terms,—the vasomotor centres may be efficient, and the nerves may be normal, but the musculature of the arterioles may not be able to respond. No theory of shock can be complete unless all these factors are given their due consideration.

The result of the experimental removal of the adrenals as well as the study of cases of pathological destruction of the glands, in Addison's disease, shows that the internal secretion of the adrenals is directly concerned in maintaining the tone of the vascular system. It is for us immaterial whether the adrenalin act directly upon the muscle-fibre or upon the end-plates of the nerves within these fibres.

Within the past few years there have appeared several articles in which the authors have presented the results of studies of the effect of narcosis upon the adrenals, and of studies of the adrenals in cases of death due to narcosis. It is to this relation of the chromaffine system to general surgical practice that I wish to call your attention. In the course of our study of the interrelation of the internal secretions, Dr. Ralph Pemberton and I have had occasion to keep dogs under ether anæsthesia for long periods, as also to extirpate one or both adrenals in addition to long periods of anæsthesia. We have not been in a position to systematically study all our experiments from the stand-point of the effect of ether narcosis upon the chromaffine system. Our observations have, however, led me to feel that the results obtained by others are, in the main, correct. I have also been able to prepare a few specimens and tracings for demonstration.

Wiesel[2] found in a number of cases of status lymphaticus an extraordinary hypoplasia of the chromaffine tissue. This finding was confirmed on a large material by Hedinger.[3] The fact that the status lymphaticus renders the patient especially susceptible to accidents of narcosis led Schur and Wiesel[4] to an experimental study of the effects of narcosis upon the chromaffine system. They found that the specific cells of the medulla of the adrenals showed a progressive loss of affinity for chromic acid salts, this decreased staining reaction becoming more marked as the time of narcosis lengthened until, after three to five hours of narcosis, no more chromaffine cells were found; synchronous with this loss of chromaffine substance was the disappearance of the mydriatic action of extracts of such adrenals on the enucleated frog's eye, and the disappearance of the iron chloride reaction. If the animals were allowed to recover from the narcosis, the chrom-reaction reappeared, the time of reappearance varying, until from eight to twelve hours later the cells possessed their normal affinity for the chromic acid salts. The extract of an adrenal after five hours' narcosis showed no physiologic effect in one experiment. The result was the same with either ether, chloroform, or Billroth's mixture.

Parkinson[5] states that he found no chromic acid reaction in the medulla of the adrenals from two cases of postoperative shock.

Hornowski[6] found in four cases of postoperative shock a condition similar to that reported by Parkinson. His experimental results are practically the same as those cited from the work of Schur and Wiesel. Hornowski's most interesting conclusions are the following: " Chloroform increases the need for tonic substance, and at the same time causes an exhaustion of the chromaffine system, which may cause death." " Chloroform does not cause an immediate exhaustion of the tonic substance, but grad-

FIG. I.

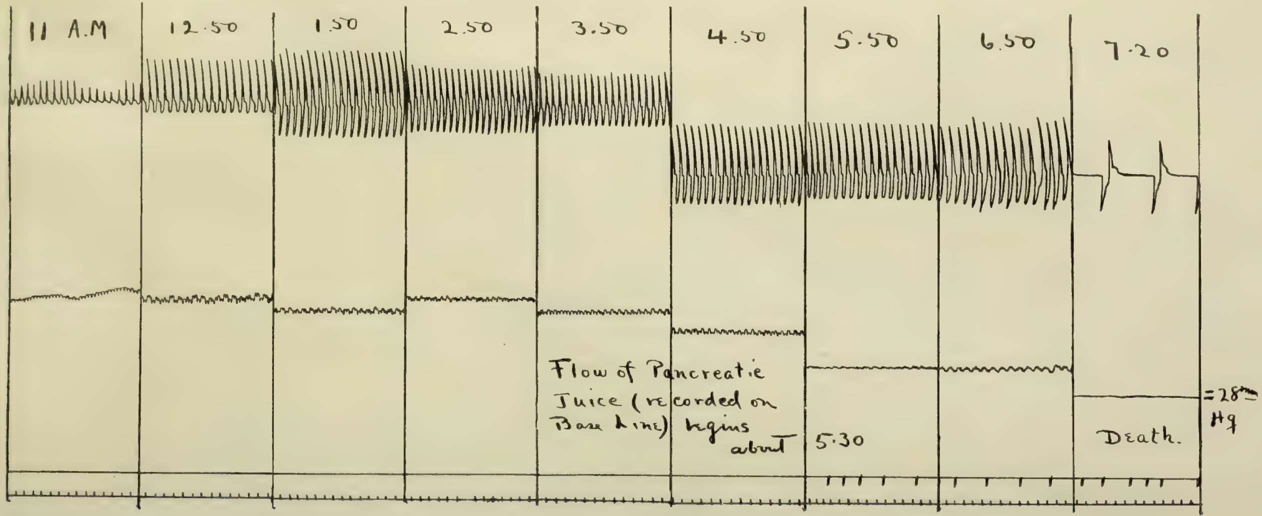
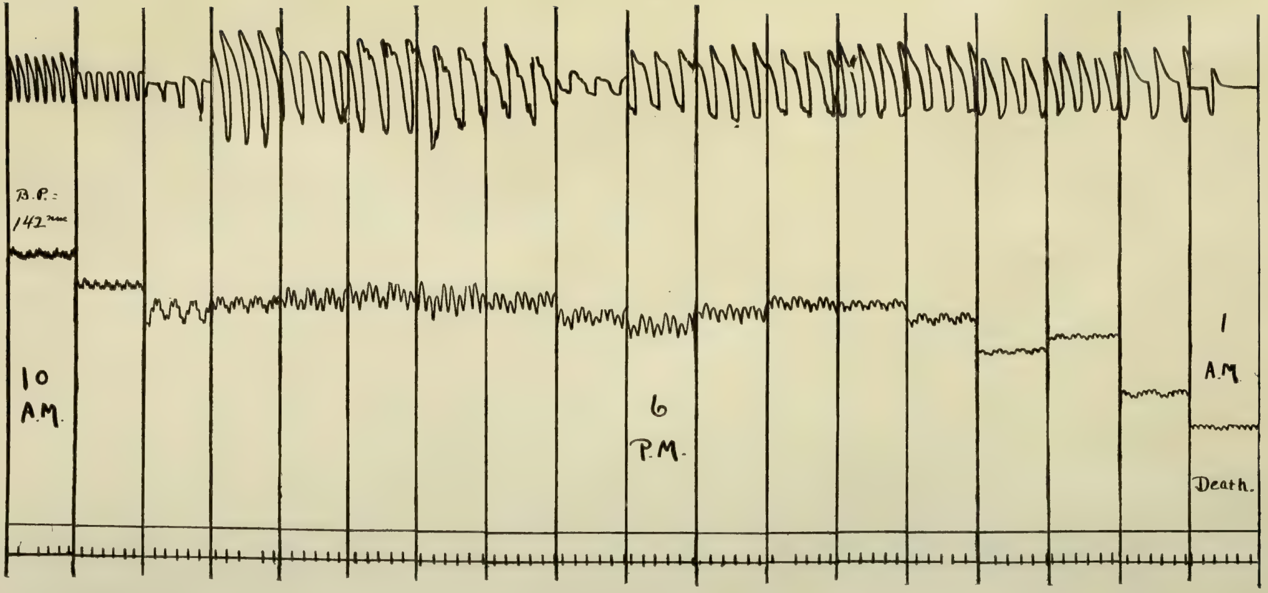

11 A.M
12.50
1.50
2.50
3.50
4.50
5.50
6.50
7.20
Flow of Pancreatic Juice (recorded on Base Line) begins about 5.30
Death.
=28mm Hg

Fig. 2.



ually, after several hours." "Chloroform may cause a sudden exhaustion of the chromaffine substance if it be not present in abundance." "The resistance of the organism to surgical shock is expressed in the possibility of satisfying a greater need for tonic substance, and in the ability of the organism to secrete it."

Kostlivy[7] reports two cases, one of death occurring 72 hours after narcosis, in which the chromaffine substance was found intact; this result he explains in the sense of a regeneration, following Schur and Wiesel. A second case in which death occurred 24 hours after narcosis showed no demonstrable chromaffine substance.

Schwarzwald[8] concludes from a study of ten cases of death during and after narcosis, in seven of which the chromic acid reaction of the adrenals was found intact, that the question of the integrity of the chromaffine tissue under the influence of narcosis does not possess decisive importance. It must be added, however, that in three of these cases fatty degeneration of the heart was noted, and a fourth was operated upon while in eclamptic coma.

Kahn[9] endeavors to prove by extensive experiments that the work of Schur and Wiesel is based upon untrustworthy technic, and that therefore their results are incorrect.

A fairly extensive series of tests with the enucleated frog's eye, carried out by Dr. Pemberton and myself in connection with another phase of our work, led us to a conclusion in full agreement with Kahn, that results obtained by this method are not dependable; yet the results seem sufficiently accurate to enable one to draw such a general conclusion as the one that narcosis affects the adrenals. At the same time it is also fair to criticize one part of Kahn's own work. He made extracts of the adrenals after narcosis and found that they always gave a positive physiological reaction, but he used no norm for comparison. It is in such experiments a question of the amount of pressor substance as compared with some normal standard, not of its absolute loss. Dr. Pemberton and I have often observed in the normal animal that the ether must be pushed beyond mere anæsthesia before an effect upon blood-pressure is obtained, so that five hours' narcosis may not have meant the same thing in the experiments of Schur and Wiesel and those of Kahn.

In reviewing the notes of the work with Dr. Pemberton, I find of our last ten experiments, in which special attention to the condition of the adrenals was directed at autopsy, nine are noted as having the gross appearance you will see in the Kaiserling preparations,—the medulla is darker in color than normal, and around the circumference of the medulla are hemorrhages which extend radially a slight distance into the cortex, giving the organ a striated appearance. In one experiment the macroscopic appearance is noted as normal. I have made a few extracts of such adrenals, and in one instance it was evidently much less active than an extract of the adrenal from a normal dog; in another no marked difference could be seen.

Nevertheless, in spite of the fact that part of the technic used by Schur and Wiesel has proved unsatisfactory in our hands, and that the reaction to chromic acid salts may be uncertain or at best may not necessarily show the condition of functional efficiency, I still feel that the facts brought out by Schur and Wiesel and Hornowski are correct. This feeling is based upon the results we have obtained by the use of entirely dissimilar methods.

The most satisfactory proof I have seen that narcosis affects the adrenals is, first, in a comparison of the curve of the blood-pressure of a dog under ether with that of a dog from which the adrenals have been removed. In both there is the same gradual, progressive fall of pressure, occurring sooner in the dog from which the organs were removed; the time of fall in the normal dog can be hastened by increasing the rate at which the ether is administered. And, second, in our study of the interrelation of the glands of internal secretion, Dr. Pemberton and I have found that the pancreas begins to secrete after the removal of the adrenals, and may show an astonishing secretory activity over a long period until the animal's death. This fact, together with the fact that adrenalin inhibits the flow of pancreatic juice which follows the intravenous injection of secretin, leads us to conclude that the adrenals exercise some sort of control over the pancreas. In the etherized normal dog this flow has never appeared; but there may, and often does, occur in the last minutes of life after prolonged etherization a flow of pancreatic juice, which we are inclined to feel indicates that the adrenals have been so affected by the narcosis that they have lost their control over the pancreas,—in other words, that the adrenals are exhausted.

In all our experiments we have a continuous record from the beginning of the experiment until the end, of the respiration, the blood-pressure, and the time in seconds, as well as the flow from the pancreas whenever it occurred. The only characteristic feature, aside from the flow of pancreatic juice in those cases where it occurs, is the gradual but progressive fall of blood-pressure; in some instances where a valvular heart lesion was found at autopsy, the addition of ether may be seen to cause sudden falls of pressure, which may sometimes be immediately fatal.

It is in regard to this point that the experience and more careful observation of the surgeon is needed to a proper elucidation of the problem. It should be perfectly evident that a change in the adrenals would not be expected in every case of sudden death during or after narcosis. It is astonishing to note that Schwarzwald included three cases of fatty heart, and one of eclamptic coma. I am of the opinion that the term "shock" should be more strictly used, and should only apply to those cases where neither the case history nor an autopsy reveals any other cause of death save the progressive fall of blood-pressure.

At the same time the solution of our problem must await a satisfactory laboratory method for determining the functional efficiency of the adrenals. It does not appear to me that a staining reaction is necessarily indicative of functional efficiency; as we have seen, the mydriatic reaction, as tested upon the pupil of the enucleated frog's eye, is unreliable for quantitative tests; the iron chloride and the sublimate reactions are of doubtful value; and even the physiologic test of extracts of the organs does not prove the point; for the amount of adrenalin is not the only variable,—the susceptibility of the musculature to the action of the adrenalin may be variable, so that what would be a functional adrenalin content of the gland in one animal would not suffice to maintain the vascular tone of another.

Two points stand out from the somewhat indefinite condition of the problem of the relation of narcosis to the chromaffine system; first, the necessity for an accurate clinical classification of cases of death due to narcosis; second, the hope that a rational treatment of cases of shock—the prophylactic treatment—may soon be materialized.

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# TRANSACTIONS

OF THE

# NEW YORK SURGICAL SOCIETY.

*Stated Meeting, April 27,* 1910.

The President, DR. ELLSWORTH ELIOT, JR., in the Chair.

## BONE METASTASIS IN A CASE OF HYPERNEPHROMA.

DR. E. H. POOL presented a man, 57 years old, who was transferred from the medical service of the New York Hospital to the service of Dr. Frank Hartley on February 15, 1910. For three months prior to admission he had suffered from moderate pain in the calf of the right leg. Soon after the pain began, he noticed a swelling just below the knee, which steadily increased in size. He had no symptoms referable to the abdomen or elsewhere.

Examination on admission showed a rounded swelling, about two inches in diameter, on the outer part of the right leg, over the head of the fibula. The skin covering it was slightly reddened, movable, and not tender. The tumor was rounded, smooth, and immovable, and evidently involved the head of the fibula. It gave a marked expansile pulsation; its size could be diminished by pressure, and the pulsation was controlled by pressure upon the popliteal artery. There was no thrill nor murmur. The knee-joint was normal; there were no enlarged inguinal nodes.

The heart was slightly enlarged, and there was a systolic murmur heard at the apex. The arteries were sclerotic. Physical examination was otherwise negative. The urine was clear, acid; specific gravity, 1010; it contained a trace of albumin and a few leucocytes.

The tumor was diagnosed as a sarcoma of the fibula, and on February 18, Dr. Pool resected the upper third of the fibula, together with the muscles attached near its upper end. The external popliteal nerve was dissected free and preserved. The head of the tibia was likewise removed as far as possible without opening the knee-joint and weakening the bone. The wound healed by primary union, and the patient could soon walk with comfort. The growth, which measured about one inch in diameter and was for the most part encapsulated, involved the whole head of the fibula; it infiltrated the muscles to a very slight extent, and at one point reached the head of the tibia. It was grayish-red in color, very vascular, and of soft consistence. The growth was submitted to Dr. Elser, who reported that the microscopical examination revealed the typical picture of hypernephroma.

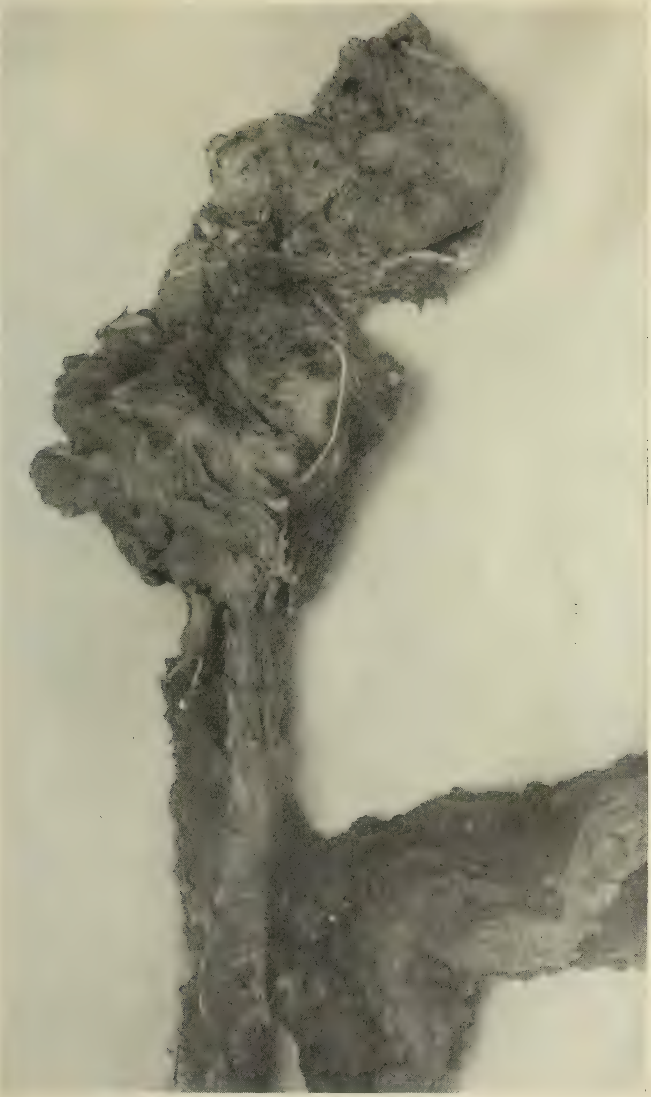
As a result of this report, renewed efforts were made to palpate the kidneys, but only a doubtful feeling of resistance could be made out over the lower pole of the right kidney. The X-ray failed to reveal anything abnormal, in or near the kidney. Cystoscopic examination of the bladder made by Dr. A. S. Taylor was negative. The ureters were catheterized, but the urines showed no notable differences: methylene blue, injected subcutaneously, appeared in the left urine in nine minutes and in the right in fifteen minutes, showing delayed secretion on that side. Red cells had been present in the urine in several subsequent examinations.

Exploration of the kidney was not done on account of the patient's poor general condition and his opposition to another operation. Weekly examinations since his discharge have revealed a rapidly growing tumor in the region of the right kidney, which was now very extensive. It was hard and nodular to the feel. The patient had lately begun to suffer from weakness, loss of appetite, and severe abdominal pains.

## GANGRENE OF THE LUNG.

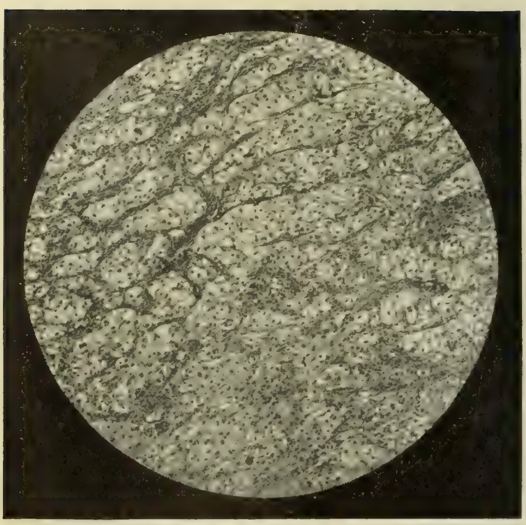
Dr. James M. Hitzrot showed two patients. The first case was a man, 34 years old, a laborer, who was admitted to Dr. W. Gilman Thompson's service at Bellevue Hospital on February 16, 1910. He complained of shortness of breath and pain in the right chest, which was increased by breathing. Eleven days before admission he had suffered from severe shooting pains in the right chest, which kept him from work, had a dry cough, had expectorated a little blood, and felt weak and sick. On admission, his temperature was 103°; pulse, 120, regular. There was dulness over the left lower chest, with bronchial breathing, but no tactile fremitus behind. Upon aspiration, a syringeful of

FIG. 1.



Hypernephroma of head of fibula

FIG. 2.



Microphotograph of bone metastasis of hypernephroma.

brownish, stinking fluid was removed. A blood count showed 45,000 white blood-cells, with 79 per cent. polynuclears.

The patient was transferred to Dr. George Woolsey's service. Operation, by Dr. Hitzrot: By aspiration, pus could be obtained only in the eighth interspace below the angle of the scapula. Under local anæsthesia, an incision was then made along the line of the eighth rib, and three inches of the rib were resected, exposing a cavity containing stinking pus and broken-down lung tissue, which came out of the chest opening in large pieces. Two rubber drainage tubes were inserted.

Following the operation, the patient's temperature ranged from 100° to 102°, falling to normal on the forty-second day. During this time, the wound had discharged foul smelling detritus; it ceased on the forty-fourth day, and now, seventy days after the operation, it had healed excepting for a slight sinus in the skin. The open-air treatment on the balcony of the hospital was followed throughout his illness. Cultures from the pus taken from the chest showed streptococci.

Dr. Hitzrot's second case of gangrene of the lung was in a man, 34 years old, who was admitted to Dr. Thompson's service in Bellevue Hospital on February 11, 1910, complaining of pneumonia. Three weeks before admission the patient had had a severe pain in the left chest, with a chill, and a dry, hard cough. Instead of improving, he had gradually grown worse during the past week. His cough had become loose, and the expectoration was profuse and very foul smelling. The pain in his chest had also become more severe, and he now had pain over the entire lower back on the left side, especially to the touch.

On admission, the patient's temperature was 105°; respirations, 40; pulse, 140. He was cyanosed and expectorating large quantities of foul-smelling fluid which separated into the three characteristic layers. His breath was extremely fetid, the odor of it filling the entire ward. Expansion was limited over the entire left back, with flatness below, and diminution of the breath sounds over the flat area. Splashing was elicited upon shaking the patient. The chest was aspirated in the eighth interspace below the left scapula, and a syringeful of stinking fluid and air were removed.

The patient was transferred to Dr. Woolsey's service, and operated upon by Dr. Hitzrot under local (novocaine) anæsthesia, three inches of the eighth rib being resected. The submuscular layer was filled with stinking pus, and a perforation in the pleura between the eighth and ninth ribs gave vent to foul fluid and air. The pleura was incised, and a large quantity of broken-down lung tissue and fluid of a very foul odor was allowed to escape. With each respiration, air entered the chest, and the finger could just reach a fairly large bronchus, the touching of which caused a paroxysm of coughing.

Numerous counterincisions were made to drain the submuscular space. Following the operation, the patient's temperature ranged between 100° and 103°, falling to normal on the forty-eighth day, at which time the discharge had ceased. Permanganate solution introduced into the chest was coughed up immediately. The wound had now healed, excepting for a slight sinus, through which air escaped, especially on coughing.

Smears from the fluid showed a varied bacterial flora, among which were numerous *streptothrices.* The culture was unfortunately lost. No tubercle bacilli were found in either case, and both showed a chest exudate originating from a necrotic process in the lung, probably postpneumonic. In the second case, this connected with a large bronchus. The diagnosis of gangrene rather than abscess was based upon the foul character of the exudate, and the sloughing cavity in the lung.

Dr. George Woolsey said a particularly interesting feature in both of these cases was the improvement that followed the balcony treatment—keeping the patients in the open air. In that environment they felt and looked better, their temperature dropped, and at the present time, from the appearance of the patients, they seemed to be in the best of health.

### EXCISION OF THE RECTUM FOR CARCINOMA BY THE PERINEAL ROUTE.

Dr. Charles H. Peck presented two cases to show the local result of resection of the rectum by the perineal route. In neither case was the condition in a sufficiently early stage to give much hope of an ultimate cure of the disease. In the first case, a deeply ulcerated growth which had already extended into the perirectal tissues posteriorly was discovered in the course of an examination for another condition, namely, right hydronephrosis, with movable kidney, and careful questioning showed that rectal symptoms had been present for many months. A further delay of two months was caused by the patient's refusal to submit to operation. In both cases the growth was low in the rectum, so that the only difficulty of carrying the dissection wide of the disease was in its immediate vicinity.

The first patient had little or no true control, as the low position of the growth necessitated the sacrifice of a large part of the sphincter, but a constipated habit kept her from soiling excepting after catharsis. She was 60 years of age, and was operated on at the French Hospital on October 27, 1909. The technic was essentially that described in detail in the two cases presented to the Society by Dr. Peck in November, 1909. Ulceration had extended practically through the rectal wall posteriorly, and there was some leakage before the growth could be excised, in spite of careful manipulation. About five inches of gut was removed, including the posterior portion of the sphincter. The tape ligature was left on the proximal segment after the usual anchorage within the denuded sphincter and wound closure. No leakage occurred for sixty-six hours, when the insertion of a trocar to allow the escape of gas became necessary on account of distention, and the following day the ligature was cut away.

The wound healed slowly, with but slight infection, and the patient left the hospital on December 20. Dr. Peck did not see her again until April 25, six months after operation, when examination showed a well-marked cicatricial stricture just above the anal orifice, and a suspicious nodule posteriorly, where the growth had originally invaded the perirectal tissues. She had gained a good deal in weight, and her general condition had greatly improved. The local result was far from ideal, but still it was a marked improvement over her condition at the time of operation.

The second patient, Mrs. A. B., aged 63 years, had noticed blood and mucus in her stools for nine months, with severe pain in the rectum, and tape-like stools for four months. The pain was especially severe on defecation and on sitting down. She had lost about twelve pounds in weight during the preceding six months. The patient was operated on by Dr. Peck at Roosevelt Hospital on February 24, 1910, for the removal of a growth which commenced about two inches above the anus and involved fully three inches of the length of the gut. The sacral glands were invaded, and there was some adhesion to the vaginal wall. The growth and glands, together with from an inch and a half to two inches of healthy gut above the growth, were excised. The technic of the operation was similar to that already described. The growth proved to be a very cellular adenocarcinoma, with glandular involvement.

Healing was prompt, with practically no wound infection. The gut was left closed ninety-two hours, when spontaneous leakage occurred at the anal margin, and the tape was cut away. The patient left the hospital thirty days after the operation with the wound perfectly healed, and with some degree of sphincter control already established.

The ligation of the gut, Dr. Peck said, was a distinct aid in avoiding wound infection. The fact that it prevented suture of the mucous membrane to the anal margin, and that the sloughing of the projecting portion was apt to extend a little above the sphincter posteriorly, probably added to the danger of anal stricture to some extent, but that had not been an especially troublesome feature in the cases which he had done, the most marked example among them being Case I, presented at this meeting. In a third case done within the past few months, in which the growth was higher up, sloughing of several inches of the gut necessitated a second operation for the formation of a permanent inguinal anus.

## PERFORATING DIVERTICULITIS OF THE SIGMOID.

Dr. Howard Lilienthal showed a man, 45 years old, who was admitted to the Mt. Sinai Hospital on March 23, 1910. His past history had no bearing on his present illness, which began about eighteen months ago, when, soon after a meal, he had a feeling of distention of the abdomen, especially in the left iliac region. At that time he was confined to bed for several weeks and had a slight elevation of temperature. A mass of considerable size was felt in the left iliac region, which gradually disappeared. It recurred, however, and at the time of the patient's admission to the hospital it could be distinctly made out. It was quite hard, and adherent to the abdominal wall. The patient's temperature at this time ranged between 101° and 102°, and he did not have the appearance of a very sick man. The intra-abdominal growth was regarded as an abscess, probably a diverticulitis, or a slowly developing perforation in the wall of the sigmoid.

*Operation.*—An incision was made through the left rectus rather low down, exposing the sigmoid, the upper portion of which was very much congested and thickened. It was tied down by a large omental mass, in separating which he encountered a small abscess cavity containing very foul pus. He separated the omentum and removed a considerable part of that portion which had been adherent to the sigmoid, coming down upon two very well marked diverticula; one of these was quite long, and communicated with the abscess. Several other diverticula were present but they were not inflamed.

The entire coil of intestine was so much thickened and so friable that it was thought wise to partially exclude it. A side-to-side anastomosis was made, and the diseased loop of intestine was side-tracked, and the wound drained through the flank. The patient made a good recovery, and the flank wound which communicated with the inflamed loop of intestine healed almost immediately.

The interest of this case, Dr. Lilienthal said, aside from its being a case of diverticulitis which was diagnosed beforehand, lay in the manner of dealing with it. The damaged loop of intestine might have been excised, but that would probably have been a dangerous procedure under the circumstances. The speaker believed that the lateral anastomosis had much to do with the patient's prompt recovery. From the location of the anastomosis, and from the fact that the drainage opening to the diseased coil closed so rapidly, he was convinced that the anastomosis was now carrying on the principal work of the intestine and was draining the diseased part.

Dr. Robert T. Morris asked Dr. Lilienthal whether the incision he had made in this case gave him the best access to that region. Personally, he preferred a gridiron incision, corresponding to the appendix incision on the right side.

Some of these cases, Dr. Morris said, might be treated conservatively. In one case where he was called upon with a view to operation, the patient had a large, distinct mass of exudate, but as he was apparently improving, it was decided to wait, and at the end of three weeks the mass was absorbed. In another case where the patient suffered from a dilated heart without compensation, there was a large intra-abdominal exudate which became absorbed without abscess formation. In all probability, the speaker said, exudates in this region underwent absorption rather more safely than in some other parts of the abdominal cavity, although waiting for absorption was not to be advised, because the original defect would be left after recovery from any one acute attack. There were unusual reasons for waiting in these two cases quoted.

Dr. Lilienthal, in closing, thought the case might have been cured without resorting to a lateral anastomosis, but at the same time the appearance of the intestine was not particularly favorable, and there were two or three areas that looked as if they might perforate. At any rate, it appeared to him that a lateral anastomosis promised the best drainage. The anastomosis was completed very quickly, taking only a few minutes, and ample drainage was thus afforded to the abscess and to the damaged loop of gut. As to the choice of incision, Dr. Lilienthal said that in approaching the sigmoid he usually went through the rectus; he preferred this to the gridiron incision, which was too far to one side.

## A CASE OF CIRRHOSIS OF THE LIVER IN WHICH THE TALMA OPERATION WAS DONE NINE YEARS AGO.

Dr. George Woolsey showed this case. The patient was a man, 68 years old, who was operated on in 1901, nine years ago. About five weeks prior to his admission to the hospital at that time he had noticed increasing swelling of the abdomen, with some difficulty in breathing. The arteries were slightly thickened; his appetite was good. Upon examination, the liver could be felt three and a half inches below the ribs; the spleen was not palpable. The abdomen at the umbilicus measured 110 cm.

Upon opening the abdomen, the liver was found hob-nailed; the omentum was thickened, and the superficial abdominal veins distended. The abdominal cavity contained a large quantity of fluid; this was evacuated, and the omentum was sutured to the peritoneum, the typical Talma operation being done. A second opening was made above the symphysis for drainage.

After the operation, there was a reaccumulation of fluid, necessitating three or four tappings, but at increasing intervals. Finally, there was no further reaccumulation of fluid. The patient resumed his occupation and was able to work until September, 1909. He was then in Florida, and had a severe attack of malaria. About this time his abdomen again became swollen, with increasing shortness of breath and loss of weight and strength. Paracentesis was performed and had been repeated several times since.

Dr. Woolsey said the interest in this case lay in the fact that this patient had enjoyed such a long period of immunity from a recurrence of his ascites, namely, from April, 1901, to September, 1909.

Dr. Lilienthal said that a few days ago he was asked to operate on a case of supposed cirrhosis of the liver, of which the patient gave every evidence. The belly was enormously distended with fluid. There was no jaundice. Upon opening the abdomen, he came down upon an extremely contracted liver, which was evidently carcinomatous. The abdominal cavity was filled with a straw-colored fluid *not* in the slightest degree bloodtinged. After removing a small specimen from the liver, the wound was closed, and the man died a few weeks later. The fluid in this case, Dr. Lilienthal said, was collected in order to use it in other cases of carcinoma, after the manner suggested by Hodenpyl. The case was one of primary carcinoma of the liver, involving the liver-cells, and the entire liver was carcinomatous from one end to the other. The organ was very much contracted, and the carcinoma was probably on a cirrhotic base. The spleen was not involved. Cases of this kind were very unusual.

## THE TREATMENT OF LARGE ANEURISMS WITH GOLD WIRE AND ELECTROLYSIS, WITH REPORT OF A CASE: EXPERIMENTAL RESULTS.

Dr. William C. Lusk read a paper with the above title.

Dr. Woolsey said he did not understand the advantages of the gold wire over an alloy of silver and copper. In one case (reported in Vol. xxxii) where he had employed this method with a somewhat stronger current, the patient had three aneurisms, and the wire was introduced into the middle sac, which was the largest of the three. A clot was readily produced, but as this contracted, the blood again had free access to the outer or traumatic sac and the man ultimately died from rupture of this sac. What was desired in these cases was to get an adhesion of the clot to the aneurismal wall; otherwise, when the clot contracted, there was a space between the clot and the wall. Such adhesion did not occur except when the intima was altered by the current passing through the wire where it was in contact with it.

Dr. Eliot asked Dr. Lusk if he had ever found any indication of embolism resulting from any method of treating aneurism, either by ligation or electrolysis.

Dr. Lusk replied that a case of embolism following the wiring operation had been reported by Salinger.

## CONGENITAL MACRODACTYLIA.

Dr. Pool showed the specimen in this case, upon which he operated at the French Hospital in June, 1907, for macrodactylia and diffuse lipoma of shoulder and arm. The patient was a boy, 2 years old, who was born with a very large right index finger. When the child was about 18 months old the mother also noticed enlargement of the right arm and shoulder.

Physical examination showed a healthy boy, normal in every respect excepting the right upper extremity. The outer parts of the shoulder, arm, and forearm were greatly enlarged by a diffuse lipoma. The index finger was about twice the normal size, the nail being correspondingly enlarged. These features were shown in the photographs.

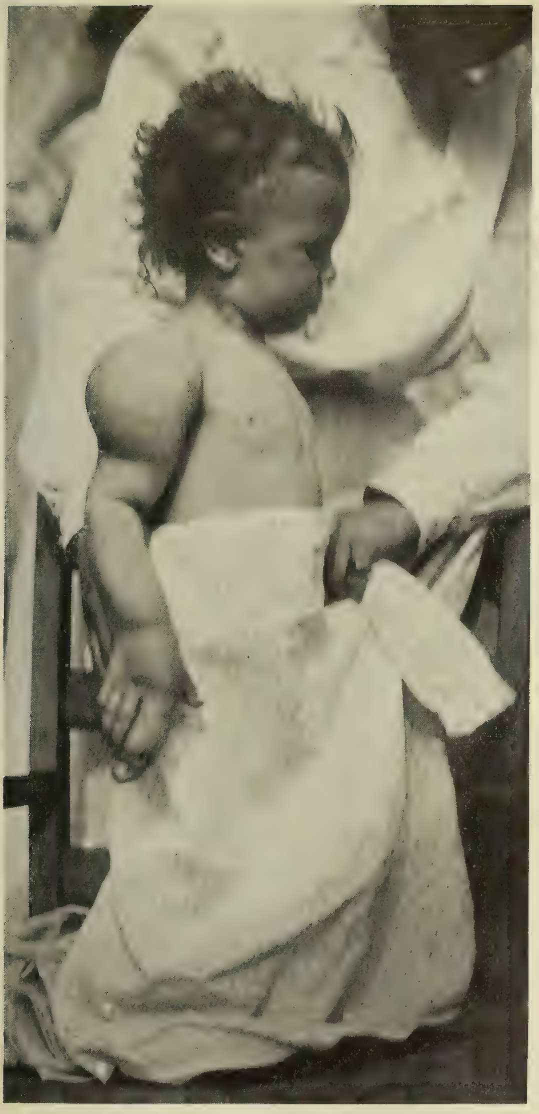
The index finger was removed at the metacarpophalangeal joint, and the most conspicuous parts of the lipoma were excised through elliptical skin incisions. Its outlines, however, were nowhere distinguishable. The wounds healed by primary union, and the boy was greatly improved in appearance.

Histological examination showed the tissues removed from the shoulder and arm to be lipomatous. The notable features in the examination of the finger were marked increase of subcutaneous fat and considerable increase in the breadth of the terminal phalangeal bone.

## EPITHELIOMA OF BOTH UPPER JAWS AND MUCOSA OF UPPER LIP: RESECTION OF BOTH UPPER JAWS.

Dr. L. W. Hotchkiss reported this case and showed photographs illustrating the condition before and after the operation. The patient was a male Italian, 26 years old, who was admitted to Bellevue Hospital on February 9, 1910. His previous history was unimportant. About two months ago he first noticed a stiff-

FIG. 3.



Congenital macrodactylia and diffuse lipoma of upper extremity.

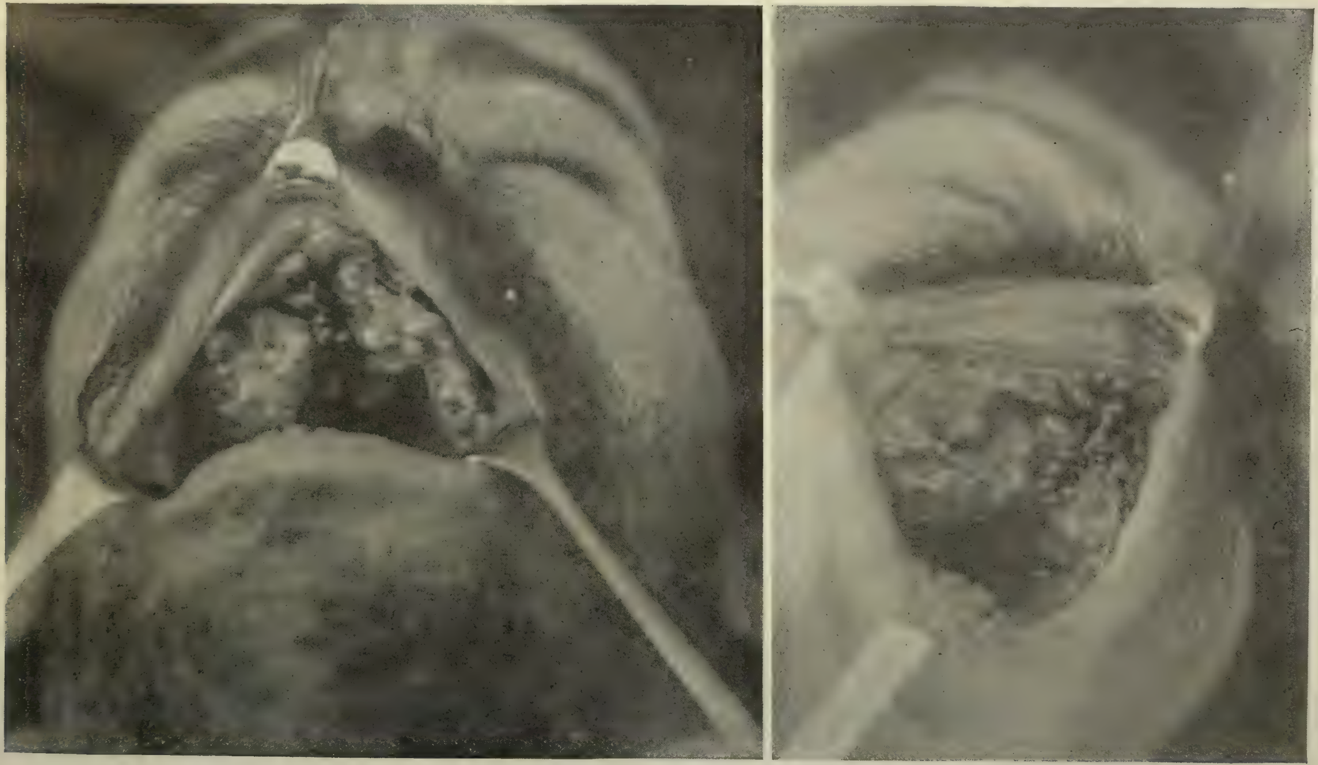
ness and thickening of the upper lip on its mucous aspect. At this time there was practically no pain. The swelling seemed to involve the gums, especially at a point where he had had three upper front teeth removed some years ago. Here there was slight swelling and some pain, and this point finally broke down into an ulcer, which gradually increased in size, involving the gums about the outer teeth, which fell out. The ulcer had been slowly increasing in size and involving more of the hard palate; it bled very readily, had a foul odor, and recently the pain at the site of the ulcerated area had been severe. The patient also complained of an almost continuous headache and pain in the back of his neck, with some stiffness. His appetite had been poor, and he had lost considerable weight, as he had been unable to eat on account of the condition of his mouth. The patient's general appearance was anæmic and wretched, the upper lip bulging, and the mouth emitting an extremely offensive odor. The growth bled very easily, and a considerable hemorrhage took place from the excision of a small bit of the tissue for microscopic examination.

*Operation* (February 19, 1910).—Ether anæsthesia was employed, preceded by a small hypodermic of morphine and atropine. Drop ether with the mask was first used, and later the anæsthetic was given by Crile's method through nasal tubes. The usual Ferguson incision for the removal of both upper jaws was made, and the greater portion of the bodies and processes of both bones were removed, excepting the orbital plates. There was moderate hemorrhage, and no preliminary carotid ligation was done. The hard palate as far back as the palate process of the palate bone, a portion of the septum of the nose, and the lower turbinals were taken away, as well as most of the body of the bone. The affected mucosa of the upper lip was also excised, and the soft parts were brought together by silk sutures and covered with a layer of cotton and collodion dressing. The patient bore the operation well, considering his enfeebled general condition, and his convalescence was uneventful, barring the occurrence of a mild erysipelas of the nose and the adjacent part of the face.

There was only slight elevation of temperature after the operation; the patient rapidly gained in strength under systematic nasal feeding and he was soon up and about the wards. The power to hold food in the mouth and swallow without leakage through the anterior nares was rapidly regained, and when he left the hospital on March 30, forty days after the operation, he could feed himself and eat solids and liquids with but very slight leakage. By this time the large cavity left by the operation had contracted considerably, and the deformity, as shown by the photographs, was very slight.

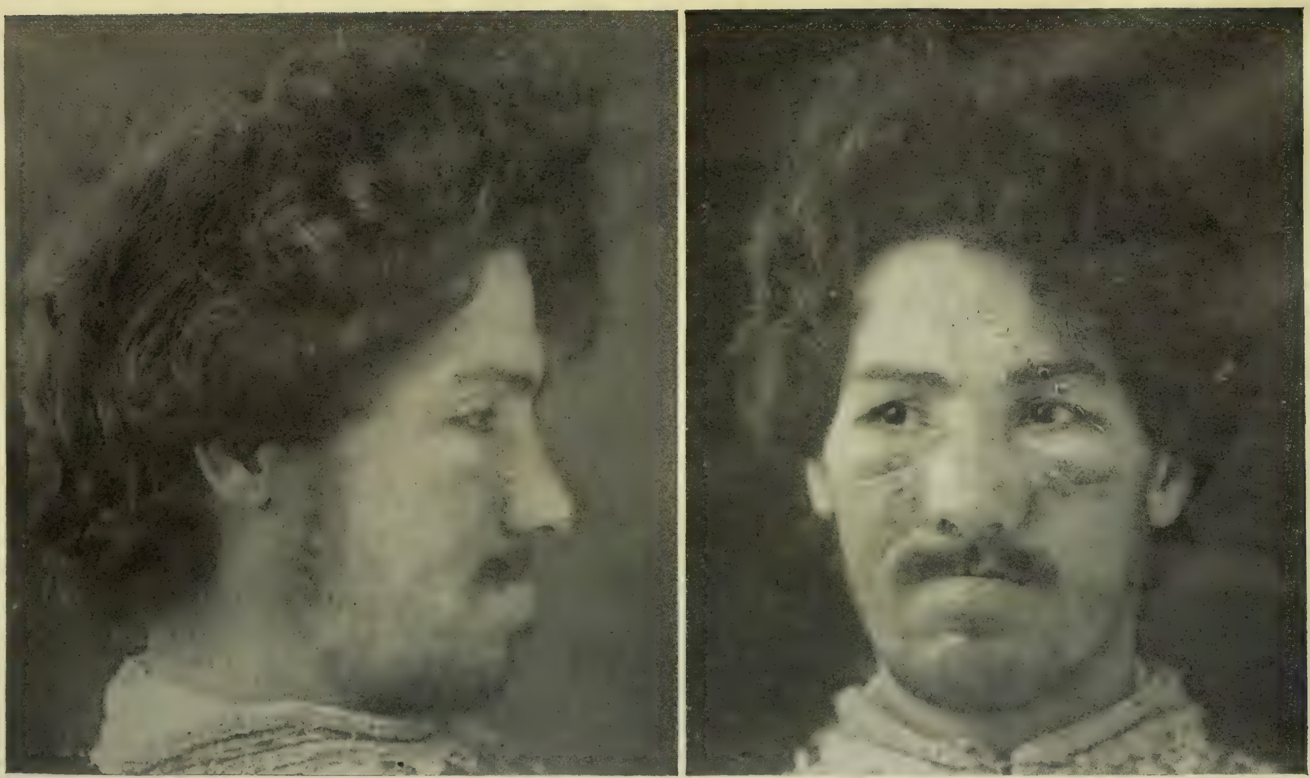
The patient was removed from the hospital by the authorities to be deported to Italy, so it would be difficult to find out how long an interval would elapse before a recurrence took place. It was certain, however, that the removal of the huge and foul, ulcerating mass from his mouth made him at least more comfortable. The photographs illustrate very well the situation and extent of the epitheliomatous growth, and the comparatively small deformity resulting from so extensive and mutilating an operation.

Fig. 4.



Epithelioma of hard palate and alveolar process.

Fig. 5.



Showing cosmetic result after removal of both upper jaws.

# TRANSACTIONS

OF THE

# PHILADELPHIA ACADEMY OF SURGERY.

*Stated Meeting held April* 4, 1910.

Dr. Robert S. LeConte, President, in the Chair.

### EPULIS AND SARCOMA OF JAW.

Dr. John M. Speese read a paper with the above title, for which see page 493.

Dr. W. M. L. Coplin (by invitation) said with reference to melanotic tumors of the jaw that he had seen specimens from a number of these cases and did not know of a single one in which recurrence did not take place. Dr. Speese spoke of the prognosis based on histological examination. This may be possible if the tumor contains many giant cells, but when dealing with neoplasms composed of round or spindle cells the method becomes of doubtful value; it is probable that in these cases the outcome depends largely upon the resistance of the patient. Usually the paramandibular tissues are not involved early, a fact depending upon the architecture of the jaw, the periosteal and intra-osteal tissues acting as a filter that resists extension of the growth.

Another point worthy of attention is the relative immunity of the submaxillary and sublingual glands. Of the specimens which come to the laboratory for examination, he had seen one in which either a submaxillary or a sublingual gland was extensively invaded. He had seen the growth almost surround a salivary gland but for some reason or other it is rare to see it penetrating the lobes or even the interlobular tissues. In all neoplasms of the mouth the salivary glands are attacked late, if at all. He had never seen a telangiectatic sarcoma of the jaw in which there has been extensive ulceration, a fact for which a fully satisfactory explanation is wanting. The jaw enlargement is accomplished by internal osseous absorption and continual subperiosteal apposition. He had one specimen removed by Professor Hearn in which the involved area of the jaw was larger than a fist, and still there was no sign of extension through the outer bony layer and no involvement of the soft parts; this tumor presented egg-shell crackling in a very marked degree.

Dr. A. P. C. Ashhurst inquired whether Dr. Speese had succeeded in following any patients treated by radical operation. It has been claimed by recent writers that it is useless to do a radical operation as the disease, if highly malignant, recurs in a few months and the patient dies; whereas an operation consisting in an evacuation and scraping of the tumor is sufficient in cases which are not so malignant.

Dr. John Speese rejoined that the diagnosis in most of the cases operated upon at the University Hospital had been made from the clinical appearance of the tumors, although in some instances frozen sections had been made when the growths had been soft and not infiltrated with lime salts or bone. In the central sarcomata, in three or four cases, the bone was trephined and sections taken for microscopic examination, the operative procedures being based upon the character of the growth, the giant cell tumors being treated by less radical measures than other types of sarcomata.

His experience agreed with that of Dr. Coplin for the salivary glands had been involved rarely in malignant disease of the mouth and jaw. Their records show that many of the periosteal and central sarcomata, both round and spindle cell in type, have been cured. The number of cases traced through the Surgical Laboratory does not permit him to state at present, however, the percentage of cures in the cases operated upon.

## ENTEROPTOSIS.

Dr. George P. Müller reported a number of cases of enteroptosis, and remarked that the abdominal organs are held in position by the negative pressure of the thoracic cavity, the mutual support of the different organs, the peritoneal, ligamentous and vascular attachments, etc. If these are interfered with, ptosis will result, and such interference may occur from congenital or acquired causes.

*The congenital type* is usually seen in a thin, pale, young woman, of slight build, with a long sunken thorax, flabby abdominal walls, a juvenile expression and a bodily form exactly like that seen in the tuberculous. The tissues are inherently weak and fragile and the actual displacements occur from secondary causes such as exhausting diseases, marked loss of weight, overstrain, lack of proper nourishment, constricting clothing, pregnancy, uterine affections, prolonged cough from bronchial affections, etc. The earlier manifestations are seen in the attacks of dysmenorrhœa and chlorosis that young girls experience and later the symptoms may be erroneously interpreted in such vague terms as neurasthenia, nervous exhaustion, chronic constipation and change of life. There is no essential difference between the symptoms due to a movable kidney, a retroverted uterus or a displaced colon except those dependent upon the drag on different anatomical supports, the general phenomena being the same.

The symptoms are referred to the digestive apparatus, the generative organs, the nervous system, or to the body generally; gastric hyperacidity, flatulence, constipation, vague abdominal pains, backache, pelvic troubles, leucorrhœa, headache, menstrual and vesical troubles, melancholia, nervousness, etc., are the most prominent symptoms and the patient complains of a total lack of energy, physical and mental. There is a lightness of weight and a general relaxation and flabbiness of the tissues.

Physically, the oblique slant of the ribs, the acute epigastric angle and the very long abdomen and small waist are characteristic. The tenth rib may be freely movable or floating (Stiller's sign). One or both kidneys are often palpable, the liver is displaced and its edge palpable, the stomach displaced and may be dilated, the colon and sigmoid are usually displaced and often redundant, the uterus may be retroverted or flexed.

A movable cæcum may produce symptoms indistinguishable in many cases from true appendicitis and Klose believes that in many of the cases of recurrence of trouble after operation without supposed chronic appendicitis a movable cæcum is at fault.

The *acquired type* is due (1) to rupture of the pelvic diaphragm from childbirth which, if extensive and not properly repaired, may after a time weaken the abdominal supports and not only the uterus but the intestines may become displaced; (2) to constipation, which by overloading the colon or sigmoid may directly induce ptosis; (3) by tight lacing which tends to force the intestines downward and loosen the liver; (4) to adhesions from inflammatory disease or from operations causing a drag upon the omentum, and by direct traction the colon is pulled downwards, and drawing upon the stomach it in turn is displaced.

No case of enteroptosis should be operated on until medical means have been exhausted without relief. The patient should be treated, if the displacement is of the congenital type, in exactly the same way as are tuberculous patients, and the outdoor life should be especially emphasized. The diet should be carefully regulated and food causing flatulence or constipation avoided. Certain drugs, especially tonics and laxatives, may be needed at times, but are of minor importance. The abdomen must be supported by an efficient bandage, and it is well to advise elevation of the pelvis for an hour or more before retiring. If the patient is young and the thorax movable she should be taught a system of breathing exercises in order to increase the capacity of the lungs and the size of the upper abdomen.

The question of when to operate is difficult to answer in the congenital type. In general, it may be stated, that if some one organ is markedly ptosed and the symptoms are especially referable to this organ, an operation should be advised, but if the kidneys, stomach, colon, uterus, etc., are all displaced and the symptoms general, operation only complicates the condition, and as Clark has said, " A pathologic condition may be left behind which imposes a still greater burden upon the defective dynamo and makes a more hopeless neurasthenic of the patient than ever."

The acquired cases, on the other hand, offer splendid opportunities for conservative surgery, the type of operation depending upon the condition causing the ptoses. Repair of the perineum, suspension of the uterus, shortening of the uterosacral ligament, suspension of the colon, of the stomach, and of the liver, are the operations most commonly practised. In addition to these the separated recti should be brought together by some operation such as Webster's. A large part of the fat may be excised from a pendulous abdomen, as recently practised by Howard Kelly, or the oblique muscles may be strengthened by some such operation as the one recently published by Coffey. In recent years a number of operators have proposed excision of part or all of the colon. Dr. Müller commends the excision of most of the transverse colon or of the sigmoid in selected cases as it undoubtedly will be frequently performed in the future, but believes that Lane's proposal to excise the entire colon and anastomose the ileum to the sigmoid is unnecessarily severe and certain of a high mortality. The operation of iliosigmoidostomy with exclusion of the colon is not rational and will probably fall by the wayside, the experimental work being decidedly against its value.

Finally, he urged the necessity for caution in these cases, as too much operating can easily be done and the results if bad are almost irremediable. The surgeon should endeavor to grasp the salient points in the cases, repair the major lesion and trust to his after-treatment to finish the cure of his patient.

Dr. William L. Rodman said with regard to gastroptosis, he personally had believed it unwise to operate on the majority of these cases, yet there are exceptional ones demanding operation. He had recently encountered such a case in a patient referred to him by Drs. Anders and Pfahler. The patient was a small woman and the degree of dilatation and displacement of the stomach was so marked that the medical men considered that the case required operation. She vomited constantly, being unable to keep anything on her stomach. Dr. Pfahler had skiagrams made several years ago and some made more recently, indicating that the stomach was twice or thrice the size it should be. The stomach was so large that it was in the pelvis; this naturally produced a kinking at the pylorus, and interfered with the organ emptying itself. It seemed that nothing short of a pylorectomy would do any good. Between one-third and one-half of the stomach was removed and the remaining portion sutured to the parietal peritoneum or anterior abdominal wall. There has been a skiagram taken since the operation, a day or two before she left the hospital, which shows now the remaining part of the stomach in good position. She has not vomited since the operation; she is putting on flesh. This is one case in which operative interference was undoubtedly warranted.

We probably have been remiss in the past in not operating on more of these cases. Undoubtedly, however, the old rule that where there is general dropping of all the viscera operation is not indicated, holds good; but, where the ptosis is limited, operation is both desirable and advisable.

## CHROMO-URETEROSCOPY IN FUNCTIONAL KIDNEY DIAGNOSIS.

Dr. B. A. Thomas read a paper with the above title.

Dr. Thomas further remarked that in chromo-ureteroscopy it is desirable to insure a perfectly colorless fluid content of the bladder, and he believes this, in many instances, can be obtained only by prolonged irrigation. In bad cases of hæmaturia or pyuria it becomes positively essential. This can best be obtained and maintained by an evacuation cystoscope which permits of frequent and speedy evacuation and refilling of the bladder, because very frequently the bladder content may become clouded and it will be impossible to judge as to the character of the elimination of the dye. An absolutely brilliant illumination is necessary so that the landmarks in the bladder as well as a weak color reaction will be distinctly visible. If these two conditions are not secured, in certain cases where there has been chronic retention of urine or chronic parenchymatous nephritis, in which diseases the elimination of the indigo as a light blue will simply ooze out of the ureteral orifices instead of being ejected as a spurt, judgment of the test will be vitiated and conducive to erroneous conclusions.

It would be of value to one undertaking the work for the first time to have the history and know the physical examination of his case. So far as the results of the cases here reported are concerned, Dr. Thomas refers the questioner to a careful review of the charts, noting the time of elimination and color reaction in detail, for it was with respect to these observations alone, to prove their value or worthlessness, that the charts were compiled.

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*Annual Meeting held April* 25, 1910.

The President, Dr. Richard H. Harte, in the Chair.

## THE RELATION OF DUCTLESS GLANDS TO SURGERY.

Dr. J. Edwin Sweet read a paper with the above title, for which see page 545.

Dr. W. M. L. Coplin (by invitation) said that recently Caccio has published in Italian a paper on cellular lipoids in which he deals with the influence of the chromic acid salts on these bodies and suggests very strongly that there is some relation between chromaffine substance and the lipoids contained within certain tissue cells. Admitting the correctness of views which Dr. Sweet has given, concerning the influence of anæsthetics, then there is a chemical explanation for the observation brought forward in his paper. If these substances are soluble in the agents used in anæsthesia, then, of course, one at once appreciates why they become so readily diffused, and why under such circumstances exhaustion of the lipoid-producing cells would be more rapidly established under the influence of agents which are in a way solvents of such bodies. One of the most interesting thoughts with regard to these observations is the suggestion that the solubility of some of these constituents of cells appears to be much greater during life than postmortem; the abstraction of these agents by known bodies in which they are soluble would seem to be accomplished less rapidly and less effectively from the excised or dead organ than occurs by circulating through the structures media containing anæsthetics or other substances which are solvents for the lipoids. This might be interpreted as indicating that the change was partly metabolic and not purely chemical. If the stage which is now considered dependent upon excitability after the administration of an anæsthetic is really due to the abstraction of pressor substances from the adrenals or other structures then a new point of view is obtained.

## ANNUAL ORATION.

Dr. Astley P. C. Ashhurst delivered the Annual Oration entitled " The Patience of Surgery."

# BOOK REVIEWS.

Duodenal Ulcer. By B. G. A. Moynihan, M.S., London, F.R.C.S., Senior Assistant Surgeon at Leeds General Infirmary, England. 8vo, 379 pages. Philadelphia and London: W. B. Saunders Company, 1910.

It would seem that during the centuries that have elapsed since human anatomy really began to be studied but little would have remained undiscovered in this particular domain. As a matter of fact, this is not the case, for each new volume that appears contains important discoveries even in the gross anatomy of the body, and the minute anatomy of some of the organs is still a sealed book.

Our knowledge of the appendix and its surgical diseases is relatively recent. All of the abdominal viscera in turn have been subjected to radical operations for the relief and cure of disease and it would seem that little remained to be accomplished.

Within the last year, however, the pancreas and the adjacent hollow viscera have been studied more and more, and it has been the good fortune of the writer of the present volume to elaborate and report a series of clinical studies and operations performed upon the duodenum, which it is safe to say will in the future be regarded as important as the work done in the early eighties by McBurney, Fowler, and other surgeons whose names are especially associated with the operations for appendicitis.

Anatomical knowledge of the duodenum is still far from complete. It is a matter of historic interest that Morgagni described a diverticulum of the duodenum for the first time in 1761, and one or two other specimens were casually reported in the century which followed. The Editor of this journal, Dr. Pilcher, described "A Large Pseudo-diverticulum of the Duodenum" in 1894 and redirected attention to this viscus. In this case the duodenum opened into the sac, and from the sac the jejunum passed. The sac presented mucosa in only one small strip. Elsewhere the parietes were devoid of epithelial lining and exhibited inflammatory changes.

In 1904, Good collected five specimens. Two of these received mere mention. For twenty years few other facts have been recorded, but within the last year or two, Dr. Wesley M. Baldwin, of the Cornell Medical School at Ithaca, has dissected and demonstrated a remarkable series of cases. As a result of casual findings in the dissecting room, Dr. Baldwin became convinced that diverticula of the duodenum were more common than is generally supposed. He carefully examined the duodenum in 105 consecutive cases, and the result of his investigations showed fifteen true duodenal diverticula. One duodenum presented two diverticula. All of these diverticula were situated upon the left or concave side of the duodenum extending towards the pancreas. Four projected directly into the gland, eight lay behind, while the other three were caudal to the head of the gland. None of the diverticula presented any evidence of inflammatory conditions. All of them belonged to the " true " variety.

Exclusive of this Cornell series, there are reports of only 67 specimens of duodenal diverticula available in medical literature. This figure, however, does not in any way represent the frequency with which these anomalies occur, for, as a matter of fact, the duodenum is rarely carefully examined at the routine autopsy, and still less frequently has it been the subject of surgical intervention.

It is the good fortune of the writer to have seen all of the specimens which Dr. Baldwin has so carefully prepared, and it was evident that many of them, forming pockets within the substance of the pancreas or extending behind the duodenum with an opening often of a size which would barely admit a probe, must be the cause of various disorders of this portion of the intestinal tract not hitherto recognized in a clinical way. The full report of this interesting series will be found in the Anatomical Record in the course of a few months.

This opinion as to the surgical importance of this condition is substantiated by the extraordinary work done by Dr. Moynihan, for there is little doubt that many of the ulcers which he found in his operations started primarily in a duodenal diverticulum.

Ten years ago ulceration of the duodenum was looked upon as a rare disease, and its confident recognition during life was believed to be hardly possible. To-day, largely as a result of Dr. Moynihan's personal observation, it is known to be a common disease and its diagnosis in the majority of cases presents no great difficulties. Indeed, the author states that in his experience, the diagnosis of duodenal ulcer is made with a degree of accuracy that is not exceeded in the case of any other abdominal disorder.

In the book itself the preliminary chapters are devoted to a consideration of the various forms of ulceration of the duodenum. "Curling's ulcer," which often follows extensive burns and scalds of the body, appears to be the most common form due to external traumatism. Uræmia, tuberculosis, or chronic nephritis play an important rôle in the etiology of this affection, and in the newborn, melena neonatorum often arises from ulceration and bleeding from this portion of the bowel. These affections are clearly described but are relatively unimportant when compared with the type of chronic duodenal ulcer which existed in the majority of cases coming under Dr. Moynihan's care.

The symptoms of this type of ulcer are definite; are easily mistaken; and appear in an order and with a precision which are indeed remarkable. Most patients give a clinical history which is of itself of the greatest importance in diagnosis. Physical signs as a rule rarely can be elicited by abdominal palpation. When bleeding occurs as evidenced by hæmatemesis or melena, the prognosis is much more grave than any similar bleeding following ulceration of the stomach. Quite characteristic is the fact that pain, instead of occurring immediately after the ingestion of food, begins three or four hours later at a time when the stomach is practically empty and about the time when the patient begins to feel hungry for his next meal.

The chapter, Symptomatology, is one of the most important in the volume and should enable any one thoroughly familiar with it to make an accurate diagnosis. It is worthy of note that the so-called acid dyspepsia is practically synonymous with this disease, but as a matter of fact, hyperacidity rarely if ever exists. In some aggravated cases which had extended over years, a test of the stomach contents showed little more than half of the normal acidity.

The treatment is essentially surgical in character. No records exist of operations performed after the primary attack, but after the second attack, a number of cases have been operated and the diagnosis confirmed. Four methods of treatment are open to the surgeon: first, excision of the ulcer; second, gastro-enterostomy; third, resection of the duodenum with or without the pyloric portion of the stomach; and fourth, resection and end-to-end anastomosis, the pylorus being left intact. Each of these operations is clearly described, and the illustrations which are well executed add materially to the value of the text.

Perforation is a complication which frequently occurs in the later stages of the disease, and its possibility should be borne in mind in all cases in which the appendix, the gall-bladder, or the duodenum are objects of suspicion. Even in these severe cases recovery has followed a timely operation. Dr. Moynihan personally reports eleven such cases with but four deaths.

The pathology of duodenal ulcers receives much attention, and in the Appendix there is given a summary of all the cases operated upon by Dr. Moynihan and his associate, Dr. Collinson. For the nine years ending in 1908, 186 cases occurred—males 137, females 49. Eight patients were operated upon twice. The results are truly extraordinary, for up to the end of 1909, the mortality of the whole series was 1.6 per cent., and among the last 121 cases there was no death.

Altogether this volume is one of the most satisfactory to the student, the clinician, or the operating surgeon that has appeared for years, and one which in the future is bound to be the basis for many independent lines of investigation.

HENRY P. DE FOREST, M.D.

THE SURGERY AND PATHOLOGY OF THE THYROID AND PARATHYROID GLANDS. By ALBERT OCHSNER and RALPH L. THOMPSON, St. Louis, C V. Mosby Co., 1910. Octavo, pages 391.

In this book the large clinical experience of the senior author and the special attainments in pathology of the junior author have been combined to present in the most full and satisfactory manner the present knowledge and teachings with reference to the diseases of the thyroid gland. To this has been added the main facts which have been ascertained with regard to the parathyroid glandules.

The book is very freely illustrated, its style is clear, its teachings are plain, and its pages cannot fail to reward either the student or the experienced surgeon who desires to measure his own observations by the standard of others.

The operation of thyroidectomy is minutely described and most elaborately illustrated. This chapter may be considered as presenting in a most satisfactory manner all the elements of the modern methods of removing the diseased thyroid which have been elaborated of late years.

The authors in this book present to us what they consider to be the best, and give their reasons why it is the best. A very considerable part of the book, two-fifths of it, is devoted to the consideration of the parathyroid glandules, the surgical importance of which, in connection with the results following the removal of the thyroids, has so recently become demonstrated. Present knowledge of these little bodies and all their relations is fully set forth by the authors and adds very materially to the value of the volume as a whole.

THE PRACTICE OF SURGERY. By WALTER SPENCER, M.S., M.B. (London), F.R.C.S. (England), Surgeon and Lecturer Westminster Hospital, and GEORGE E. GASK, F.R.C.S. (England), Assistant Surgeon St. Bartholomew's Hospital. Philadelphia: P. Blakiston's Son & Co., 1910.

The preface heralds the fact that this book is in its tenth edition, a feature in itself to command attention because it attests to the popularity of this "Practice of Surgery" originated by the late W. J. Walsham, of St. Bartholomew's Hospital.

The editors, Messrs. Spencer and Gask, refer to the many courtesies of the collaborators whose contributions have kept this work abreast of the times by the revision and introduction of much that is materially new. Thus a chapter on blood examination, a revision of the section on Ophthalmic and Aural Surgery and many fresh skiagrams are recorded. Likewise emphasized are the additions in orthopædic surgery, the illustrations of museum and histologic specimens, and the drawings bearing on cystoscopy. The chapter on urethritis has been rewritten by Powell.

This book, certainly rejuvenated by these accessions, is in a fair position to gain many adherents among American students of surgery.

Its commendable features are the presence in one volume of general and regional surgery and the most important afflictions of the specialties. The work reflects the teaching of up-to-date surgery and mirrors the practice of the English school.

MARTIN W. WARE.

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## ORIGINAL MEMOIRS.

# ATONY OF THE BLADDER WITHOUT O C TION OR SIGNS OF ORGANIC NERV DISEASES.*

BY J. W. THOMSON WALKER, M.B., F.R.C.S

OF LONDON,

Assistant Surgeon to St. Peter's Hospital.

To the surgeon, atony of the bladder is a sufficiently familiar phenomenon. For clinical purposes such cases have hitherto been arranged in two well-defined groups, those which the atony results from obstruction to the outflow and those in which organic nervous disease is present to explain the want of contractile power of the bladder. To the fo group belong cases of enlargement, simple or malignant, of the prostate, and stricture; to the latter group, the cases of diseases of the spinal cord when the nervous control of the bladder has become early and severely affected. These cases usually drift to the surgeon under mistaken diagn stricture or some form of obstructive diseases. The is another class of case of nervous disease, where the appeals to the surgeon for relief of secondary phosphatic stones in the bladder, or of chronic cystitis, resulting from

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* A lecture delivered at the Medical Graduates College, London, on June 2, 1910.

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ved no abnormality. I could find
evidence of nervous disease, and referred him to Dr. Purves Stewart, who reported that "his pupils, cranial nerves, sensory, motor, and reflex functions were all normal."

CASE II.—G. W. B. (VII, 526), a wood machinist, aged thirty-seven, was brought to me by Dr. Robert Purdie. Fourteen years ago he began to have difficulty in passing water, and this had gradually increased. During the past four months there had been a decided increa [illegible] plete retention. [illegible] only once a day [illegible] formed from a s [illegible] to wait for some minutes be [illegible] The stream was [illegible] induced by strai [illegible] frequently had t [illegible] commenced agai [illegible] There were no [illegible] had a specific gravity of 1000, and conta [illegible] bladder was dis [illegible] pint of urine was removed, and the bladder was still palpable above the pubes. The prostate was normal in size, with a broad median sulcus. There was no stricture or other obstruction to the introduction of large instruments. Cystoscopy showed well-marked trabeculation of the bladder, which was most marked on the right side. The trabeculation extended to the apex, but was not so pronounced at the higher part of the bladder as at the base.

The orifice of a solitary small diverticulum with sharply cut edge was seen to the right and behind the right ureteri [illegible] e. The trigone and ureteric orifices were normal. The urethral orifice was normal. I could find no evidence of nervous disease, and Dr. Purves Stewart confirmed this opinion.

CASE III.—G. W. (VII, 141), a lamp-lighter, aged [illegible], came under my notice at St. Peter's Hospital in March [illegible]10, complaining of "stoppage of water." Four years ago he noticed that the stream was slow and small, and he made water "pretty frequently." Two years ago the difficulty increased, and he almost had retention, but it was not quite complete.

He had little desire to pass water, and would go all day from morning to night without attempting to do so. Usually, however he passed water three or four times during the 24 hours, from the belief that it was proper for him to do so, but not from any desire.

There was a delay of a half to one minute in commencing micturition. The stream was poor, dropping, and intermittent. There was a good deal of after-dribbling. There was some aching in the right sacro-iliac synchondrosis, but he had no actual pain. On one occasion he had passed some blood in the urine after a long bicycle ride.

He had lost flesh and strength during the last 18 months. He denied venereal disease. A year before I saw him, an instrument had been passed at two different hospitals under the impression that there was a stricture.

On examination the prostate was small and elastic, and noth- [illegible] ectum. A large instrument was [illegible] a hitch. There were 20 ounces [illegible] n and 22 on another. There was [illegible] tion of the bladder and a small [illegible] on the right wall. The prostate [illegible] or intravesically. Dr. Purves [illegible] l any evidence of organic disease [illegible]

[illegible] aged thirty-four, complained of [illegible] g the bed at night. He gave the [illegible] cted syphilis in 1895, and was [illegible] t noticed difficulty in micturition [illegible] 8. The frequency amounted to [illegible] lay and not at all at night, and [illegible] s to half-hourly frequency during [illegible] here was a difficulty in starting, [illegible] ne minutes before the flow com- [illegible] St. Peter's Hospital in 1901 with [illegible] was intermittent and there was [illegible] e had to go to stool to get the [illegible] as found, there was no residual [illegible] d by the cystoscope, was healthy. [illegible] ed " by the surgeon in charge of [illegible] l to be relieved.

[illegible] e still complained of difficulty in [illegible] g during the act. The flow was [illegible] ith fair force, but gradually fell [illegible] e bladder was full and he lifted [illegible] little urine escaped; there was a [illegible] also at any undue muscular exer- [illegible] ry hour and a half to two hours [illegible] ht for the past 12 months. The [illegible] ctum. The urethra admitted the largest instruments without obstruction. There was moderate trabeculation of the bladder and some dilatation of the vessels at the trigone. There was no intravesical enlargement of the prostate. There were seven ounces of residual urine. There were no signs of nervous disease.

Case V.—J. G. C. (V, 533), a wireman, aged fifty-nine, was sent to me at St. Peter's Hospital in May, 1908, by Dr. C. W. Chapman. He was in good health until 18 months ago, when he showed symptoms of plumbism, for which he was treated.

He then came under Dr. Chapman's care for aortic and mitral lesions, and was sent to me on account of dribbling of his urine. He stated that four months before I saw him he had experienced scalding and great difficulty in passing water. Some time later he began to dribble at night, and this had continued. He passed water four or five times a day in a poor dropping stream. He had noticed a swelling of the abdomen for six weeks.

When I examined him the bladder was greatly distended and reached well above the level of the umbilicus. He suffered from thirst, headache, and a dry skin, and his appetite was poor. The tongue was dry. The prostate was small and soft. I admitted him to the hospital and his urine was slowly drawn off. There was no obstruction in the urethra. After the bladder had been emptied, the urine was drawn off twice daily. There was marked trabeculation of the bladder. The prostate did not project into the bladder. Dr. Purves Stewart found no organic nervous lesion.

Case VI.—H. C. (V, 584), a laborer aged thirty-three, came under my observation at St. Peter's Hospital in May, 1908. He stated that he had suffered from difficulty in making water and some frequency for five years. The onset was gradual. Instruments were passed at a general hospital, but without any improvement in his symptoms. The frequency of micturition increased after this, and he passed water every quarter of an hour during the day, but not at all at night.

He was attended at St. Peters' Hospital in 1904, when it was noted that his urine was clear, with a few filaments. He passed water every hour and four or five times at night. Instruments were passed from time to time, but without improvement in his symptoms. In March, 1906, he was admitted to the hospital, and the urethra examined under an anæsthetic. Large steel instruments were passed, but no stricture was found.

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In January, 1909, he stated that the difficulty had increased.

He waited a minute before any urine appeared; the flow commenced gradually, the stream was poor, and dropped a few inches from the meatus, and finished up in a dribble. There was occasionally burning in the urethra after micturition. The urine was clear. He denied syphilis, but admitted an attack of gonorrhœa 26 years previously.

The urethra admitted large instruments without obstruction; the prostate was normal in size and consistence. There were four ounces of clear residual urine. The bladder showed trabeculation. No symptoms of organic nervous disease could be detected.

Case IX.—A. P. (VII, 479), a joiner, aged sixty, consulted me at St. Peter's Hospital in May, 1910, in regard to difficulty in micturition. He thinks he got a chill 12 months ago, and from that time the water passed slowly and with difficulty. This had been increasing, and three months ago he began to pass water at night. The water became thick six months ago and he once noticed some blood in it.

At the present time he waits half a minute before micturition commences; at first it dribbles and gradually gets a little stronger. At its height the stream is small and drops a few inches in front of the penis. It tails off into a dribble. There is suprapubic pain and pain to the right of the umbilicus on micturition. He is losing flesh a little. There is no history of stone or gravel. He denies syphilis, but states that he had one attack of gonorrhœa. The urine is cloudy with well-mixed pus and shreds. On examination the bladder was found to be distended to a little above the level of the umbilicus. The prostate was small and elastic. There was no obstruction to the passage of large instruments. The nervous system shows no sign of organic disease.

The nine cases that I have related fall under neither of the two preliminary categories into which cases of atonic bladder are ordinarily divided.

First, no evidence of obstruction could be obtained. The anterior urethra was examined in most of the cases with the urethroscope under air distention. In all of them large metal instruments were passed ($^{13}/_{15}$ to $^{15}/_{17}$), and the vesical orifice of the urethra was examined with the cystoscope. The rectal surface of the prostate was examined with the finger and the vesical surface with the cystoscope. No abnormality was detected by these methods. Second, no signs of organic nervous disease could be elicited. In four of the cases I had the advantage of an opinion from Dr. Purves Stewart. In sifting the cases I have been particularly careful to exclude cases of early and irregular forms of disease of the spinal cord.

I shall now examine the characteristics of these nine cases. With two exceptions the symptoms commenced below the age of 40 years, and most were under 30 years (22, 23, 37, 22, 28, 38, 30, 59). There was a history of syphilis in ses and of gonorrhœa in four others. The remaining atients denied venereal disease. The common feature ie cases was the gradual onset and increase of difficulty urition. The flow did not start promptly, there being e of some seconds or even minutes before the urine o pass. The stream was feeble. It might commence ir force, and then fall away into a dribble, or it might at the start and gradually increase in strength and lapse again into a dribble. It usually dropped a foot way from the patient. The stream was often inter- —sometimes it was only projected at all by forced of the abdominal muscles with a fixed diaphragm. respiration the flow ceased and recommenced as the gm was again fixed and the compression renewed. untary effort might be insufficient to start the stream and in one instance the patient had to wait a quarter our before the flow became re-established. At the end rition the stream again fell away into a dribble. In case had there been acute retention, and this recurred ne to time, and required the passage of a catheter.

Chronic distention of the bladder was present in four cases, the bladder reaching up to and above the umbilicus. In these cases the power of voluntary micturition remained, although greatly impaired. In the remaining cases residual urine was present and varied in amount from four to ten ounces. In one case there was an escape of urine on coughing and on any muscular effort. In this case, and in another, there was nocturnal dribbling from an over-distended bladder. In two cases the frequency of micturition was diminished. These patients informed me that they had no desire to pass water at any time. They might pass water once or twice in twenty-four hours, and if they did so oftener it was from a sense of fitness, not from any sensation of distention or of necessity. There were three patients who passed water more frequently than normal, as often as every hour during the day and several times at night. In two of these cases there was no question of the increased frequency being due to cystitis or other inflammation, for the increase had commenced spontaneously, before the passage of any instrument, and the urine was absolutely clear. In two of these cases there was no trace of inflammation in the bladder; in the third, the bladder base was somewhat puffy, and in this case there were a few filaments in clear urine. Any inflammation that might have been present in this case was insufficient to explain the frequency of micturition.

On cystoscopy there was in all these cases well-marked trabeculation of the bladder wall. This was usually general; sometimes one side was more trabeculated than the other, usually the trabeculation was less marked in the region of the apex than elsewhere. In three cases the trabeculation was extreme. In two less pronounced cases a solitary small diverticulum was present.

There was occasionally dilatation of the veins at the base of the bladder. The mucous membrane was clear and healthy in all except one case, where it was slightly puffy at the base. The ureteric orifices were normal. In one case the interureteric bar was thickened.

I shall now turn to discuss some points in regard to these cases.

1. What was the condition of the muscular apparatus of the bladder?

In dealing with the symptomatology, I have noted that the power of expelling the urine was diminished to a varying extent. This reduction of the effective power of the detrusor muscle was measured by the manner in which the act of micturition was performed, and by the quantity of residual urine. The loss of power of the detrusor muscle usually commenced insidiously and was progressive; occasionally the onset was almost sudden and some amount of the power was regained. In one case the atony suddenly increased after being moderate for 14 years, so that the bladder became distended to above the level of the umbilicus. In another case there was a greatly distended bladder after 12 months, and in another after 18 months.

The condition of the muscular wall as shown by the cysto- was very striking in all these cases. In all of them there arked trabeculation, and in two the trabeculation was excess of anything that I have seen in other diseases bladder, of whatever nature. Where the trabeculation derate in degree it affected the lateral walls low down e trigone, and to a less degree, the apex of the bladder. le of the bladder might show trabeculation while the as smooth. In some of the cases a tense, sharp band of passed across a portion of the bladder wall and the ove or below this was deeply hollowed. Where the ation was present in a marked degree, it was universal, of the bladder being affected, except the trigone, which d unaltered. The larger muscle-bundles were sharply and widely separated. They stood out like round cords nched into smaller strands, which disappeared in the network. Between these larger bundles there were shaped depressions of varying depth, the walls of which fine secondary interlacing muscle-bundles.

degree of trabeculation did not correspond to the of residual urine, nor to the duration of the symptoms. tient with 20 ounces of residual urine, and symptoms which had lasted for 14 years, had a considerable degree of trabeculation most marked on the right side; another patient with an equal quantity of residual urine and symptoms for four years showed only slight trabeculation, while a third with four ounces of residual urine and symptoms for five or six years had universal trabeculation of an extreme degree.

Trabeculation has hitherto been regarded as a sign of hypertrophy of the bladder, and its presence has been looked upon as proof that obstruction to the outflow of urine was present. I have long suspected that there must be other factors in the causation of trabeculation of the bladder, which might act with obstruction or apart from it. In the first place I have frequently observed trabeculation of the bladder where obstruction to the outflow was certainly absent, where there was no difficulty in micturition, and where there was no obstruction to the introduction of full-sized instruments through the urethra. I should be departing too far from the object of this article were I to bring forward more than one case in support of this statement.

Let the following example suffice:

I saw F. M., a barrister, aged forty-six, in consultation with Dr. F. E. Batten. He gave the following history:

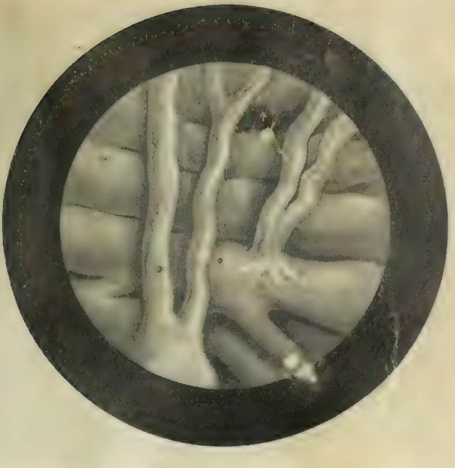
In May, 1909, he had an attack of hæmaturia following a game of golf, and there was some pain in the left side of the abdomen. The urine cleared and on examination contained hyaline and finely granular casts, a few red blood-corpuscles, renal cells, and calcium oxalate crystals. In November, 1909, he had an attack of renal colic on the left side, which lasted twelve hours. A radiogram showed a small calculus in the pelvic segment of the left ureter. He had no increased frequency until he was put on diuretics and large quantities of barley water, when he passed a good quantity of water every two hours, and rose once at night. There was no difficulty, pain, or discomfort on micturition. The prostate was normal in size and consistence, and there was no obstruction to the passage of large instruments. There was no residual urine. On cystoscopy the ureteric orifices were normal, and the mucous membrane of the bladder healthy. There was very marked trabeculation of the bladder, which was well distributed over the bladder. It was most marked at the base and at each lateral wall and not so marked at the apex. Dr. Batten assured me that there were no signs of organic disease of the nervous system. The trabeculation in this case was not due to hypertrophy produced by obstruction.

Nitze was the first to observe trabeculation of the bladder with the cystoscope in the early stages of tabes dorsalis, while Orth and others have described the condition post mortem in old-standing cases of tabes.

In an article on this subject Bohme[1] has described eight cases of tabes dorsalis in the early stage in which trabeculation of the bladder was present, and he looks upon this condition of the bladder as a diagnostic sign of tabes in the earliest stage. My own experience of the bladder in tabes is confined to 31 cases, nearly all of which were of the peculiar type in which
dder is early affected whilst the other nervous symp-
re insignificant, and they usually came to me without
owledge of their nervous disease. These cases corre-
o those on which Bohme writes. In these cases some
of trabeculation was usually present. It was, however,
equently absent, and in none of the cases was the
of trabeculation so extreme as in two of the cases I
st described.

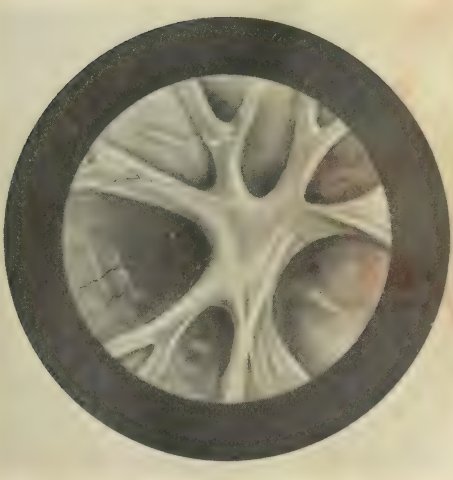
e is, therefore, I submit, a considerable body of evi-
o show that trabeculation of the bladder may be
l in a pronounced degree quite apart from any of the
orms of urethral obstruction with which we are
. There is a difference between this form of trabecula-
d that which is observed in obstructive diseases. The
lation of an obstructed bladder is coarse, the muscular
thick and irregularly branching, and the interspaces
ouched; the openings of the saccules are often narrow
). In the trabeculated bladder without gross obstruc-
e muscle ridges are fine and evenly set and the branch-
gular and orderly (Fig. 2). Very fine twigs can fre-
be seen branching and interlacing. The interspaces
so deep and in my cases were usually saucer-shaped. The distribution of the trabeculation is also different. In the obstructed bladder the trigone is broken up into hypertrophied ridges. The ureteric bar is hidden among a number of thick trabeculæ, and it is often difficult to find the ureteric orifices. The rest of the bladder is also affected. In the unobstructed

FIG. 1.



Trabeculation of the bladder due to hypertrophy (case of enlargement of the prostate).

FIG. 2.



Trabeculation of the bladder due to atrophy (Case I).

trabeculated bladder, as Bohme has pointed out, the side walls and the apex of the bladder are affected, while the trigone escapes.

In the cases that I have just described the trabeculation was sometimes localized or more marked on one side than on the other. The area usually affected in such cases lay outside and behind the ureteric orifices and there might be a solitary area of trabeculation here while the rest of the bladder surface was unchanged. A solitary muscle band sometimes stood up strongly for a considerable distance. Such fine distinctions, while they do not invariably hold good, may certainly be recognized in the majority of cases.

Bohme adopts a theory which V. Frankl-Hochwart advanced to explain difficult micturition and retention in disease of the spinal cord, namely, that the sphincter is unable to relax, and he looks upon the trabeculation in cases of tabes as due to this cause acting as an obstruction. According to this author, therefore, these tabetic bladders are to be ranged along with that of enlarged prostate and of stricture. I do not feel satisfied with this explanation. In one of my cases the bladder sphincter shared in the atony of the detrusor, for there was an escape of urine on coughing or on any muscular exertion, and in this case, with only seven ounces of residual urine, and another case, with from four to six ounces of residual urine, there was unconscious dribbling at night. Obstruction by the sphincter could, therefore, be excluded in these cases. The trabeculated bladder, which is not secondary to any of the tangible forms of obstruction, such as enlarged prostate or stricture, may be explained in another manner, if we can rid ourselves of the belief that trabeculation necessarily means hypertrophy. I would venture to suggest that the earliest change in these cases is atrophy, and that the prominence of some muscle-bundles is largely due to atrophy of the neighboring bundles. The greater calls that are made on the surviving bundles may be supposed to call forth a compensatory hypertrophy, but this is insufficient to do more than partly replace those that have atrophied. This suggestion fits in well with the condition observed in cases of diseases of the spinal cord, for it is one of the characteristics of these cases that a considerable amount of improvement may take place in the muscular power of the bladder after the first few months or year of the atony.

2. What was the condition of the sensory apparatus of the bladder?

The sensibility of the bladder in these cases varied. In
s it was certainly blunted, if not abolished. The
elt neither the sharp sensation of the contact of urine
mucous membrane of the prostatic urethra, nor the
tension and weight above the pubes and in the peri-
penis that is experienced by normal individuals.
ients would go through the whole day without pass-
and without discomfort. On the other hand, there
e cases where frequent micturition and urgency were
t symptoms. In these cases the urine did not show
of cystitis, and the cystoscope displayed no inflamma-
e mucous membrane of the bladder was undoubtedly
itive in these patients. In the remaining cases there
ppear to be either diminution or increase in the sen-
the bladder.

cystoscopist is familiar with the difficulty which a
periences in commencing micturition after the pros-
ra and bladder-base have been rendered anæsthetic
of cocaine instillation. The inability to pass water
arter or half an hour and then passes off as the effect
rug disappears. While the prostatic urethra and
se are still anæsthetic, it is often possible by a voluntary effort to start micturition, and, once started, the flow is sustained, with a force as great as in a normal individual. If micturition cannot be initiated and a catheter is passed, the fluid flows with as much force as where no anæsthetic has been applied. When urine has been passed voluntarily from a cocainized bladder, there is no residual urine left if none was present before the application of the anæsthetic. It therefore appears that anæsthesia of the bladder or of the prostatic

urethra, if judged by this standard, can only prevent the initiation of micturition, but does not affect the contraction of the bladder muscle once it is started.

Dr. Parkes Weber[3] has recorded an interesting case of paralysis of the bladder in a man aged 57 years. The patient was not aware whether his bladder was full or empty. Dr. Weber suggested that "a local hypo-anæsthesia (occurring as an early symptom of nervous disease) was an important factor in this retention of urine and vesical dilatation." This theory is inapplicable to the cases I have recorded, for the following reason: anæsthesia of the bladder, as I have pointed out, may prevent micturition by preventing its initiation, but once micturition is started, the stream is full and strong, and no urine is left behind as the result of the anæsthesia.

In my cases the stream was not merely delayed, as in cases of anæsthesia, but it was also feeble. Whether passed through the urethra or through a catheter, the want of force was obvious. Moreover, there was a quantity of residual urine in all the cases. If anæsthesia were the cause of the vesical inefficiency, there should have been an absence of initiation of the act and therefore complete retention and inability to micturate in all the patients, but this was not the case. And further, as I have shown, there was hyperæsthesia of the bladder in three cases.

3. The relation of these cases to vesical atony, secondary to obstruction.

Atony of the bladder, partial or complete, is most familiar to the surgeon as a result of gross enlargement of the prostate. It occurs also as a result of stricture of the urethra. Such lesions are readily demonstrated.

There is a class of cases that require more careful consideration, for they are more difficult to diagnose and exclude. I refer to cases where there is slight enlargement of the prostate, or atrophy of the prostate, or fibrous conditions at the internal meatus.

It is well known that enlargement of the prostate may produce sufficient obstruction to cause chronic retention of urine without any enlargement being detected on rectal examination. Such cases are not common, but they are of sufficiently frequent occurrence to receive general recognition. In these cases there is either a small pea- or cherry-like intravesical projection of the prostate or a prominent rim, at the back and sides of the internal urethral orifice, that has been aptly called a "collar-like" projection of the prostate. Such changes are recognizable by means of the cystoscope. They [illegible] nt when the bladder is opened above the pubes, and the [illegible] is inspected or palpated.

Another form of obstruction that cannot be recognized by rectal palpation is "contracture of the neck of the bladder." In this condition there is a fibrous thickening of the tissues [illegible] the internal meatus. It appears to result from old-standing inflammation, usually of venereal origin. There is [illegible] on at the entrance of the bladder to the passage of [illegible] ts. Stenosis of the orifice can also be detected by the finger introduced through a suprapubic cystotomy wound. With contracture of the neck of the bladder or apart from it, there may be atrophy of the prostate, which results from a [illegible] ause. Atrophy of the prostate is easily recognized by the finger from the rectum.

Any of these conditions may cause obstruction to the outflow of urine, and they must therefore be carefully excluded [illegible] palpation, by the passage of sounds, by cystoscopy, and if necessary, by suprapubic cystotomy.

In selecting my cases I have rigidly excluded all cases where [illegible] lity of the prostate or prostatic urethra or vesical [illegible] the urethra could be detected by any of these methods. The following case came under my care before I realized that there might be atony without obstruction or signs of nervous disease.

Case X.—G. H. (1906, II, 246), a healthy man of sixty-three years, was admitted to St. Peter's Hospital with chronic retention and overflow.

Four years ago his urine began to dribble and his bladder was found to be distended. His doctor passed a catheter.

For three years he passed a catheter twice daily, and then was advised to cease using the instrument with the result that he had pain and difficulty in micturition. The urine has been foul and there has been hæmaturia. When I examined him, he passed urine every two hours and rose once at night. There was urgency to pass urine, but he had to wait five minutes or more before the flow commenced. There was pain at the meatus before micturition, and scalding during and after the act. The stream was poor in force and small in volume, and sometimes stopped in the middle of the act. There were clots of blood in the urine. He had had an attack of gonorrhœa at the age of twenty years. No symptoms of organic disease of the nervous system could be elicited. The prostate was normal in size and consistence. There was a quantity of residual urine, which contained blood and muco-pus. On cystoscopy there was cystitis and the bladder was trabeculated and there were sacculi. The prostate was not prominent in the bladder.

On August 1, 1906, the bladder was opened above the pubes and the prostate was examined. The prostate did not project into the bladder, and was small bimanually. Under the impression that I might have to deal with a case of contracture of the neck of the bladder, I forcibly dilated the prostatic urethra with my finger. Dr. Young of Baltimore was present at this operation, and suggested that a perineal prostatectomy should be done.

On August 30 the patient had recovered, but was entirely dependent on his catheter, passing no urine voluntarily. The urine was clear and without deposit.

On September 5 I performed perineal prostatectomy dissecting away both lobes of the prostate. The patient was discharged on October 6 healed, and with clear urine, but absolutely dependent on his catheter.

From this case I learned that atony of the bladder might exist without signs of nervous disease, and be unrelieved by operation undertaken with a view to remove any possible obstruction.

4. The relation of these cases to tabes and other forms of disease of the spinal cord.

I have already referred to cases of early and irregular tabes as a cause of atony of the bladder and I do not intend to discuss these cases at present in detail. It is necessary, however, to consider whether the cases I have described do not at a later period develop symptoms of tabes or other disease of the cord. None of these cases developed symptoms of disease of the spinal cord while they were under my observation. One might, I think, reasonably expect some symptoms of organic disease to develop in, say, three or four years after the bladder condition had become established. The following was the duration of the symptoms in these cases on the first occasion on which I examined them, and some of the patients have remained under my observation since: (1) five or six years, (2) fourteen years, (3) four years, (4) twelve years, (5) four months, (6) five years, (7) eight years, (8) two and one-half years, (9) three months.

I think there is here sufficient evidence to prove that these cases do not belong to the early and irregular forms of spinal disease.

*Etiology and Nature of these Cases.*—There is little information to be obtained from these cases in regard to etiology. So far as I could ascertain, only two patients had suffered from syphilis. One patient had had lead poisoning.

The reflex centre for the contraction of the bladder and the inhibition of the sphincter is placed, according to general belief, in the lumbosacral cord at the level of the third and fourth sacral segments. In diseases of the spinal cord, such as tabes, this centre is supposed to be affected, and atony of the bladder results as one of the symptoms of this disease. It is more difficult to explain the occurrence of disease confined to this centre affecting no other part of the cord.

Clinical and experimental researches by Goltz, Freusberg[4] and Ewald,[5] and C. R Müller[6] have shown that the lowest reflex centres, which control the functions of the bladder and rectum and the erection of the penis, are situated in the hypogastric and hemorrhoidal plexuses of the sympathetic. The cases that I have recorded are, I believe, to be explained by the existence of some lesion of this sympathetic reflex centre. This would explain the absence of symptoms of disease of the spinal cord which is a feature in these cases.

It is interesting to follow these cases into their later stages, and to note how secondary complications supervene and eventually conceal the original nature of the case. Without exhausting the resources of my clinic at St. Peter's Hospital, I have selected the following cases as representing the later stages of the disease.

Case XI.—W. J. J., a journalist, aged fifty-three, was sent to me by Dr. J. M. H. MacLeod, complaining of thick urine. Eighteen years before I saw him, when thirty-five years of age, without apparent cause and without warning he suddenly lost the power of passing water. Since that time he had never passed urine voluntarily. All his urine was drawn off by catheter, which he passed himself without difficulty. His bladder became infected, and the cystitis varied in severity from time to time. He admitted one attack of gonorrhœa, but denied syphilis. When I examined him he was passing his catheter every two hours during the day and twice at night. The urine was foul and thick with shreds and mucopus. There was no obstruction to the passage of instruments through the urethra. The prostate was small but not atrophied. There were no signs of organic disease of the nervous system.

Case XII.—W. E., a coachmaker, aged forty-three, complained of inability to pass water. The onset was gradual two years ago when there was difficulty in passing water. This increased until he could pass no water voluntarily, and was entirely dependent upon his catheter. He drew off the urine from four to six times during the day and four or five times at night. A small stone formed in a pouch in the bladder and was crushed and removed. The urine was thick, alkaline and stinking. There was no obstruction to the passage of instruments and the prostate was normal. The bladder was trabeculated and showed numerous saccules. There were no signs of organic nervous disease.

In the twelve cases here described, we have to deal with atony of varying degree. The urethra shows no sign of obstruction, and the prostate is healthy; there are no signs of organic disease of the nervous system. In a number of the cases the atony has been present for a sufficient period of time to be certain that tabes or other disease of the spinal cord will not develop. There are acute and chronic cases. Such cases, I submit, form a class by themselves.

*Literature.*—There is little in the literature that bears directly on these cases. A few cases have been published, which appear to me to be similar in nature. Albarran and Noguès [7] have recorded two cases of retention of urine in young men, which they were unable to explain and could not classify. Mr. S. G. Shattock [8] described a post-mortem specimen of dilated bladder and ureters, and suggested that that condition was of "infantile origin" and analogous to idiopathic dilatation of the colon. The case may possibly belong to this group. I have already referred to a case recorded by Dr. Parkes Weber which he regarded as one of early nervous disease. It is possible that this case was similar to those described. Professor Casper [9] has recorded two cases of chronic retention of urine, one of which had signs of nervous disease and the other had none. The latter case appears to me to be similar to those I have described.

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# CERTAIN CONGENITAL STRICTURES OF THE URETER.

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A CASE of congenital stricture of the ureter which came under our observation at the Carney Hospital led us to examine medical literature for pertinent information. To our surprise we found that the text-books of surgery either dismissed the subject with few words or said nothing at all of it. We could find but scant information (chiefly scattered reports of one or two cases) in English and American medical literature. A search of the German and the French, however, disclosed reports of several series of collected cases as well as interesting discussions of the general subject. Such information as we have been able to cull from these sources and from a study of additional cases will be set down in this paper. The subject in its entirety goes far beyond the limits of a single communication, and only that phase of it exampled by our own case will be treated herein.

Ureteral stricture may be congenital or acquired. Of the latter, which is the less frequent, we shall have nothing to say. We shall have to do only with congenital stricture and shall regard the word " stricture " in its wide sense, including in the term any narrowing of the ureter even up to complete impermeability, sharply localized narrowings as well as those which may include the whole or any part of the structure. In other words, we shall treat of congenital atresia (narrowing) of the ureter, partial, complete, or even accompanied by aplasia (imperfect development).

## EMBRYOLOGY.

A grasp of the essential features of the embryonic development of the genito-urinary apparatus will enable us to understand better the possibilities arising from congenital faults, and will determine more clearly the limits within which we propose to hold this discussion.

In early embryonic life the genito-urinary and the intestinal tracts have a common termination in the cloaca. The first rudiment of the permanent renal system (the ureter and the kidney) arises at the beginning of the second month of fetal life as an outgrowth with a narrow lumen from the dorsal side of the Wölffian duct, close to the termination of the latter in the cloaca. This outgrowth, the renal bud, the stalk of which represents the adult ureter, develops in a general upward direction and soon shows at its blind (upper) extremity a bifurcation, the forerunner of the adult renal pelvis; the two divisions of the bifurcation represent the chief renal calyces in the adult. The mesodermal tissue surrounding the bifurcation and its branches contributes to the formation of the adult renal parenchyma. In time the cloaca shows a tendency to differentiation, becomes smaller, and the common opening of the ureter and Wölffian duct is now in the bladder, to the formation of which the cloaca and allantois have contributed. In the further course of development the ureter and Wölffian duct begin to separate (from above downward), and the segment common to both finally disappears, the ureter and duct acquiring separate openings; these are at first close to each other, but subsequently, because of the enlargement downward of the space between them to form the prostatic urethra, they are far apart, the ureter terminating in the trigone of the bladder and the Wölffian duct (the future vas deferens, etc., of the adult) in the prostatic urethra as the ejaculatory duct. In the meantime, the cloaca as such has vanished and the hindgut has separated entirely from the anterior division. In the female the Wölffian duct practically disappears entirely; usually only an unimportant remnant remains in the broad ligament. Occasionally, however, it persists as a completely or partially open duct (Gärtner's duct) passing down in the superficial tissue of the cervix and vagina and terminating in the vulvar cleft at the outer side of the vaginal opening near the duct of Bartholin.[1] This is, of course, but a mere outline of the story. To those interested in the detail of the embryologic development of the genito-urinary tract and in anomalies resulting from congenital defects and vagaries therein, Huntington's[2] Harvey lecture (upon which I have drawn for much of this paragraph) will be most attractive.

It is chiefly important for us to carry along three facts bearing on this phase of the subject, viz.: (1) the early common cloacal termination of the rudimentary genito-urinary and intestinal tracts and their subsequent complete separation; (2) the primary origin of the ureter from the Wölffian duct, which in the male represents the future vas deferens, ejaculatory duct, etc.; and (3) the early common opening of the ureter and Wölffian duct in the embryonic bladder and their later acquisition of separate openings, at first close together but finally far apart. Now with these facts in mind it is clear that an arrest or a failure or an imperfection of development may have to do with an ureter opening or evidently intended to open, (1) into the intestinal tract, or (2) into the genital tract, or (3) into (*a*) the bladder or (*b*), as a rare occurrence, elsewhere usually in connection with some persistent remains of the Wölffian duct. With the first two of these divisions the paper will not deal. It will be limited to a discussion of congenital strictures of such ureters as may be included under class *a* of the third division. Cases falling under class *b* have been reported by Förster,[3] Secheyron,[3] Vrolik,[3] Ortmann,[3] and Tangl.[4] Though they form an interesting series, no further consideration will be given them here, and only such congenitally strictured ureters as open, or were evidently intended to open, into the urinary bladder will be brought into question. Much that will be said of them would be equally true of such ureters opening into the intestinal or into the genito-urinary tract, but these divisions have sufficient matter peculiar to themselves to merit separate consideration.

## ANALYSIS OF CASES REPORTED.

In 1896 Schwarz,[5] in the course of a long general article, reported 22 cases which come within the limits of this paper. To these Welz[6] added six cases in his Inaugural Address in

1903. Twenty-eight additional cases * (making a total of 56) will appear in this paper, 22 of them representing scattered, hitherto uncollected reports from medical literature. Six cases are reported here for the first time, one through the courtesy of Dr. F. H. Nichols of the Boston City Hospital, another (Case I) by the kind permission of Dr. E. Channing Stowell of the Massachusetts Infant Asylum, three others by courtesy of the Drs. Mayo, Rochester, Minn., and the sixth, a personal case from the surgical service of the Carney Hospital.

Of these 56 cases, 25 occurred in males, 16 in females, while in 15 cases (including monstrosities and pathologic specimens) no mention of sex was made. One would expect, however, that it would have no particular influence here.

A study of the ages shows that in some cases the defect is immediately incompatible with life, that in others it quickly develops to that stage of incompatibility, that in still others it remains latent in its effects till in some way infection starts up, and that in many it exists unsuspected during life and is found only at autopsy after death from other causes. To avoid tiresome figures, it may be said that a very striking feature is the number of cases discovered in subjects under five years of age and in those over sixty; in other words, at the extremes of life.

Forty-five cases had to do with single and 11 with supernumerary ureters. The left ureter was affected in 27 instances, the right in 17, both ureters in 10, and two reports fail to mention the side affected. Of the 11 supernumerary ureters, 6 were on the left side and 5 on the right; in 6 the upper ureter and in 3 the lower was affected. In 2 cases the supernumerary ureters merged into a common trunk near the bladder. All this is not entirely in agreement with Veau,[7] who speaks of the frequency of the congenital defect in connection with supernumerary ureters and asserts that the upper ureter is almost always affected.

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* Since I had received the proof of this paper for correction, Dr. E. A. Codman, of Boston, called my attention to two cases which he had reported and which I had overlooked. These appeared in the Boston Medical and Surgical Journal of May 28, 1908, and of August 5, 1909.

### ETIOLOGY.

The exact etiology of the defect is, of course, obscure. Men of equal repute sometimes hold diverse opinions as to the cause of certain features of the same case. It is generally agreed, however, that the malformation is the result of a primary defect, or of an arrest of an earlier embryonic stage, or of a secondary retrogressive metamorphosis. Mutach considered his case (Case XXVII) to be the result of an arrest of a fetal stage, contrary to the opinion of Virchow, who looked on it as the result of a past inflammatory process. Weigert believed that the cystic kidneys in his case (Case XXVI) were not the expression of a primary defect, nor of an arrest of development, but of an entirely secondary process. This seems reasonable, inasmuch as the upper portion of the ureter and the renal pelvis develop from and after the lower ureter, and in such a case as Weigert's the lower part of the ureter must have existed once and have been destroyed. Still, whatever the etiologic factors may be, our interest in them is only academic; for over them as causes we can have no control, and it is through their effects alone that they appear and appeal to us.

### LOCATION AND RESULTS.

Now these effects are concerned with two factors, (*a*) the location and the form of the stricture, and (*b*) its after results.

*The Location.*—In several instances (Cases XXVI, XXXI, *v.g.*) a portion of the ureter was wholly fibrous, while in others (Cases XXVIII, XXXIII, XLIII, L, LI, *v.g.*) the ureter was impermeable throughout and was represented only by a fibrous cord—a functionless ureter. Teyssèdre[8] collected reports of 11 such cases. The further development of this defect leads to absence of the kidney and of the whole or a portion of the ureter. Teyssèdre reported 74 observations of this condition. In 8 cases of our series the stricture was located in the upper third of the ureter, usually at or close to the opening into the renal pelvis. In 36 instances the obstruction was in or very close to the bladder. Nichols's case showed stricture both at the upper and at the lower end of the same ureter, and Allen and Parker's at the lower end of one ureter and at the upper end of the other. The same ureter may present alternating portions with and without a lumen (Case XXVII). However, leaving the great rarities aside, it is fair to assume that the ureter, if present, in the great majority of cases reaches the bladder and that the stricture is usually in or very close to that organ.

*The Form.*—This varies very much. It may be represented by a sharply defined narrowing (Cases XL, LIII), or may take the form of a section with a length varying from one-fourth inch to four inches of the calibre of a fine probe. The stricture may be passable or impassable.

The most important, and, in their effects, the most far-reaching modifications of form are seen in the obstructions at the lower end of the ureter. In these the ureter usually reaches the bladder and in most instances ends there in a blind sac. This blind end may be just beneath the mucous lining of the bladder, may lie in the muscular layer of the bladder wall, or may just reach the outer wall. If the blind end is in the muscular layer and one examines the bladder from within, either there will be no trace whatever of an ureteral opening, or in its place will be seen a dimple, a shallow invagination of the mucous membrane. If the blind end is just at or in the outer layer of the bladder wall (and this is a rather unusual occurrence), there may appear just above it a localized dilatation of the ureter which takes the form of a cyst just behind, *i.e.*, outside, the bladder (Cases XIX, XXII, XXXII). It is conceivable that this external pocket, if large, may compress the bladder, crowding in the posterior wall, or may, in women, even bulge the vesicovaginal septum.[9] In Case XIX, the cyst was as large as an egg. In some similar cases, this localized cyst-like formation does not take place, but the ureter becomes dilated throughout its length.

The most interesting forms, however, have to do with the ureters ending just beneath the vesical mucous membrane. These produce a cyst-like protrusion of the mucous wall into the vesical cavity. The protrusions range in size from that of a small pea (Case V) to one completely filling the bladder (Cases XI and XIV); the smaller are usually hemispherical in shape; the larger are either triangular or finger-shaped, sometimes reach the vesical opening of the urethra, may pass varying distances along the course of the latter (Case XII), and in women may even appear at the external meatus (Cases VI, XIII, XVII). When empty, they are flat and flaccid; when full, are finger-like, pear-shaped, and tense, broader and thicker at the base, and gradually tapering and thinning in the direction of the tip. Occasionally one ends in a bulbous enlargement (Case VI). They exhibit lengths varying from 0.5 cm. (Case I) up to 6.5 cm. (Case IX). The diameter at the base varies from 2 cm. (Case XII) to 5 cm. (Case IX). They are lined on one side by the ureteral and on the other by the vesical mucous membrane. The ureteral opening into these pouches may be bristle-like or may be an aperture 2 cm. in diameter. In all Brinon's[10] observations the protrusion connected with an ureteral dilatation. Such a condition would be expected; for usually (in 12 out of 17 cases in this series) the protrusions are blind cul-de-sacs without an opening into the vesical cavity. In 5 cases there was a communication between the protrusion and the vesical cavity, almost invariably by minute openings at the tip or on the side of the former. A supernumerary ureter gave rise to this form of ending in 8 cases, a single ureter in 9 cases. It is usually unilateral, but Burckhard reports an instance (Case II) in which it was bilateral. The contents of the protrusions is usually a clear fluid; it may vary considerably in color in shades of brown and yellow. Sometimes a muddy or cloudy fluid is seen (Cases VIII and I).

*Effect on Ureter.*—When the obstruction is at the lower end, the ureter is almost invariably dilated, thin-walled, and tortuous. It varies in size from that of a pencil to that of the small intestine. Various observers use descriptive terms which range from " dilated " to " tremendously " and " enormously dilated." It becomes widened and lengthened. Occasionally it is lobulated, shows windings and twistings, kinks and folds, and has been described as having "the appearance of a string of sausages." In such cases the wall on section is found to be thin and to show valve-like folds, which in places narrow the lumen. This may represent a persistence of the fetal type of ureter; for Hamann[11] finds that spindle-shaped dilatations and tortuosities of the ureter are nearly constant in the fœtus and therefore normal. Byron Robinson,[41] too, notes that all mammals possess ureteral dilatations and constrictions, which are, in his opinion, heritages from the Wölffian body, enhanced by environment, as erect attitude. It is an anatomic fact that where an ureteral constriction exists from heritage or is a pathologic condition, an ureteral dilatation will exist proximal to it.

In but three cases (Cases II, IX and XVI) is the ureteral wall described as " thickened," though Förster asserts that the walls keep their normal thickness or grow thicker. This was certainly not true of our own case. Intercurrent inflammatory processes, however, might produce such a condition. Shield (Case XXXVIII) reports an unusual case in which an enormously dilated ureter filled the whole pelvis with its distended coils, which pressed on the rectum and on the other ureter. In but one instance (Case XXVIII) in this series was mention made of the fat layer about the ureter and pelvis to the frequency of which Veau called attention. When there is a double ureter, the two, though usually in the same fibrous envelope, ordinarily follow separate paths. Veau, however, has often seen the dilated abnormal ureter twine about the healthy ureter. Förster relates what is probably a unique case (Case XLVIII) in which a much-dilated right ureter opened into the bladder on the left side. The effect of obstruction at the upper end of the ureter is too well known to deserve description here.

*Effects on the Pelvis and Kidney.*—Here the effects are striking; for either an enormous hydronephrosis or a most marked primary atrophy may result from ureteral obstructions of the same location and character. It is only fair to state that, judging from a study of the present series, hydronephrosis of varying degree is the rule. It may show itself simply as a slight or a moderate distention of the pelvis, or it may present as an enormous cyst filling the whole abdominal cavity, with only remnants of the true kidney tissue in the cyst wall (Case XVI). Between these extremes many intermediate grades are seen. Infection, direct or indirect, produces its usual disastrous effects, and in some cases completely disorganized kidneys are found. In kidneys with supernumerary ureters, that half of the organ from which the affected ureter runs usually shows characteristic hydronephrotic changes, while the rest of the organ is normal. The only exception occurs when both ureters unite to form a common trunk after leaving the kidney.

Several cases (Cases VIII, XI, XXXIX, XLV, *v.g.*) of this series showed a marked degree of renal atrophy, the kidney in one case (XXXIX) being of the size of a bean. Study of these cases shows no sufficient reason why atrophy should have ensued rather than hypertrophy. Undoubtedly, some of the cases were examples of secondary atrophy, but a microscopic examination would probably have proven some of them to have been primary. Lindemann[12] produced complete exclusion of the ureter by ligature in six dogs, and in three simple primary atrophy of the kidney followed, while in three others simple hydronephrosis was the result. He concluded from a careful experimental study of the subject, that whether a primary atrophy of the kidney or an hydronephrosis develops in animals after ligature of the ureter depends on the grade of development of the compensatory anastomosis through the vessels of the capsule. The intrapelvic pressure following the ligature blocks the renal vessels coming in at the hilus, and the further effect of the ligature depends on the amount of blood the kidney substance can get through anastomosis between the kidney substance and its capsule. Kidney atrophy means a primary insufficiency of compensation through the blood supply of the capsule. On the contrary, if the capsular blood supply is free, hydronephrosis will follow, and the fluid will accumulate again and again after tapping. Sollman, Williams, and Briggs,[13] in a series of experiments somewhat like Lindemann's, found hydronephrosis in every case (four dogs). Chemical examination of the fluid thus accumulating in the kidney showed it to be a transudate poor in proteids and chiefly noteworthy because of the absence of notable amounts of the specific urinary constituents. Complete ureteral obstruction, then, probably means rapid cessation of the true secretory function of the kidney; if a collection of fluid ensues, it is not urine but is a transudate (Case XI). Partial obstruction does not mean such cessation, and the resulting accumulation of fluid is an uronephrosis (Lindemann). Almost all cases of the present series showed what was practically a complete ureteral obstruction; the reports of such as showed partial obstruction contained no chemical study, and consequently no further information on this point can be drawn from them. In the light of our present knowledge it is very probable, however, that Burckhard's case (Case II) was one of uronephrosis rather than of hydronephrosis. The same is true of Drew's cases (XXXV, XXXVI). Lindemann's conclusion as to the occurrence of hydronephrosis and atrophy has been generally accepted.

Of course, in the above paragraph true primary atrophy of the kidney is meant in contradistinction to the atrophy secondary to hydronephrosis, which is a progressive pressure atrophy with flattening of the papillæ, obliteration of the uriniferous tubules and of the glomeruli which goes on till only a few remnants of kidney tissue remain flattened out in the wall of the cyst. Lindemann asserts that for true hydronephrosis persistence of the glomeruli is characteristic.

Several cases of the present series showed in place of the kidney only a conglomeration of cysts, several separate pockets. Whether they represent primary congenital defects or are the last stage of a secondary process is not apparent.

The kidney of the opposite side shows only hyperæmia and compensatory hypertrophy in the uncomplicated cases.

*Effects on the Bladder.*—The cystiform protrusions of the blind-ending ureter into the bladder may cause marked secondary pathologic changes in the bladder, in the other ureter, or in the other kidney. The protrusion from a supernumerary ureter may block the opening of the healthy ureter of the same side (Case I). The pocket may be so large as to block the ureteral opening of the other side. In other cases it may wholly obstruct the vesical opening of the urethra, give rise to a distended, hypertrophied bladder, and set going the usual sequelæ of retention of urine. Examples of all these possibilities are present in the appended abstract.

## SYMPTOMS AND DIAGNOSIS.

In our series, 19 cases gave either subjective or objective symptoms, which may be attributed with fairness directly or indirectly to the congenital trouble. In 11 cases where one might expect symptoms, none were mentioned in the histories. This, of course, does not make first-class evidence; for most of the cases were reported more from the pathologic than from the clinical point of view. Many cases occurred in subjects too young to make complaints. On the other hand, Heller instances a case (Case XVI) of a seventy-nine year old woman who died of pneumonia, in whom autopsy disclosed an hydronephrosis practically filling the whole abdomen. Boström's case (Case XI) indicates that even a moderate protrusion into the bladder may exist for some years and be without symptoms. It is, of course, sufficiently evident that a strictured ureter on one side with a resulting renal atrophy or even with a moderate hydronephrosis might exist indefinitely without symptoms, if no intercurrent infection set in.

The symptoms, in such cases as gave any, varied much, and it is impossible to draw from them any picture that would definitely determine in future cases a diagnosis of congenital stricture. Some trouble with urination, usually frequency, is the most common complaint. Cases VII and LI, and one of

Mayo's (see text) had temporary and recurrent hæmaturia. The reason for this in uncomplicated cases is difficult to understand. It is by no means a common symptom, and, when present, is usually not so to a marked degree. Yet in Mayo's case it continued for seven weeks at a stretch and was sufficiently profuse to produce pallor. Painful micturition and strangury were mentioned in one instance. Drew's cases (Cases XXXV and XXXVI), which may, perhaps, be regarded as typifying cases with obstruction high in the ureter, complained of increasing pain and discomfort in the loin and frequency of micturition; both cases exhibited tumors in the loin. Here diagnosis of hydronephrosis must have been relatively easy, but the congenital cause could not have been foretold. Pain in the loin with a sausage-shaped tumor rising from the pelvis was present in our case at the Carney Hospital. Cystiform protrusions into the bladder, when they are large, are apt to give very marked symptoms, both subjective and objective. Boström's two cases (Cases XI and XIV) serve best to indicate what may probably be regarded as typical examples. His first case (Case XI) was that of a child six months old, who shortly after birth developed an increase in size of the abdomen which in a few weeks became very well marked. The child for days would pass no urine; when he did pass it, it was in large amounts and showed nothing characteristic. When two months old the boy had an evident three-lobed tumor, one lobe in the middle abdomen coming out of the pelvis and rising to the level of the umbilicus; each loin was occupied by a lobe of the tumor, which represented, as autopsy showed, a much distended bladder, and a double hydronephrosis caused by a cystic protrusion into the bladder sufficiently large to block the urethral and other ureteral opening. Boström's second case (Case XIV), a boy of twelve, had been healthy up to his eleventh year. Then night incontinence began; six months later frequent, painful, and difficult micturition was present. At that time the abdomen began to increase in size, and a fluctuant, movable, non-sensitive, kidney-shaped tumor was found rising out of the pelvis to the level of the umbilicus, its upper end free and its lower end fixed in the pelvis apparently to the bladder. The right loin was more resistant than the left, but no tumor could be made out there. In the left lumbar region could be felt a sausage-shaped mass. The urine was negative. The autopsy showed an atrophied left kidney, a much dilated left ureter, a distended bladder, and a marked right hydronephrosis, all the result of a cystic protrusion into the bladder blocking the urethral opening. These, of course, are marked cases and for that very reason are quoted somewhat at length.

Schwarz [5] in commenting on these cases makes some pertinent observations with regard to diagnosis. In such a case as Case XI, for instance, catheterization of the bladder, while it might remove some urine, would nevertheless not cause the median tumor to disappear wholly, and the tumors in the loins would be entirely unaffected. He calls attention to the possible significance of the long-continued retention of urine, alternating perhaps with involuntary micturition, which last would occur in the horizontal position with elevation of the pelvis because of the falling back of the distended cul-de-sac from the urethral opening. How practical these suggestions are is questionable. Much would depend, it seems to us, on the degree of distention of the cul-de-sac and the closeness of its application to the bladder wall.

The Cooper-Rose case (Case LI) also is instructive from a diagnostic stand-point. The patient, a woman of twenty-eight, had for thirteen years been treated for a supposed ovarian tumor, which occupied much of the left side of the abdomen. For eleven years the patient's general condition was but little disturbed. Then pain and discomfort began. After her death at the age of thirty it was found that the tumor was a huge left pyonephrosis secondary to a wholly impermeable left ureter.

This congenital condition may coexist with other surgical kidney affections. In Lilienfeld's case (Case XV) and in one of Mayo's (Case LII) a stone was found in the renal pelvis.

In both these cases the stricture was at the vesical end of ureter. In another of Mayo's cases (Case LIII) an almost complete stricture was found 1½ in. below the kidney in the course of a nephrectomy for a tuberculous pyonephrosis. There was no explanation for the stricture other than on congenital grounds; the ureter below it appeared entirely healthy.

The urine is usually negative. Nichols's case and our case showed a moderate leucocytosis and a moderate rise of pulse-rate and temperature, but it is by no means clear that the ureteral condition had anything to do with this.

Infection will bring its usual train of symptoms. It is more to be feared in these cases because it may reach and affect the remaining sound kidney with disastrous results. The cystiform protrusions that have been of sufficient length to protrude from the external meatus, and have either sloughed or have been punctured, have invariably become infected, and always with fatal outcome.

Perhaps a knowledge of the existence of cases of congenital stricture of the ureter and of its results, and a more careful examination with that knowledge in mind, would have made a pre-operative diagnosis possible in Nichols's case and in our case at the Carney Hospital. However, in no case yet reported has such a diagnosis been made. The present widespread use of cystoscopy will render much easier the recognition and significance of the cystiform protrusion into the bladder. Young's case (Case VII) is illustrative of this fact. Ureteral catheterization and the X-ray (collargol plate) will find wider and wider use as aids in determining the location of strictures (Cases LII and LIII).

## THE OPERATED CASES.

Cases have been operated on by Drew (Cases XXXV and XXXVI), Dudley Allen (XLVII), Wipple (XXIV), Mayo, Nichols, and the author. In no case was the diagnosis made previous to operation. Of Drew's cases one was cured and the other relieved, by pyelo-ureteroplasty, of the effects of congenital stricture near the renal pelvis. A perusal of his report makes one consider whether some of the cases instanced as examples of misplaced or abnormal origin of the ureter from the pelvis may not be more apparent than real, and whether the true situation may not be a pelvis so dilated through the effects of an ureteral obstruction (probably high) that its lowest level is forced below the point of origin of the ureter, thus causing that point to appear abnormally elevated. Again, his reports lead us to advise that in all cases of so-called idiopathic hydronephrosis not only should aberrant blood-vessels be sought for, but the calibre of the upper ureter should be carefully explored for stricture. To us these considerations appear practical.

The cases operated by Dudley Allen and by Wipple are also interesting, but for quite a different reason, in that they show how effective is a simple nephrostomy even in patients both of whose ureters must have been entirely obliterated at some point. In each case after a nephrostomy on one side all the urine escaped by the nephrostomy wound, none passing by the urethra. Wipple's patient, a woman of twenty-five, had had a right nephrostomy at the age of fourteen, and since that time had discharged all her urine through the operative opening; in her twenty-fifth year a left pyonephrosis made necessary extirpation of the left kidney. Recovery followed. Allen and Parker tell of a two and a half year old boy on whom a nephrostomy was done for a hydronephrosis filling the whole right side of the abdomen. Following this, practically all the urine was passed through the operative wound; yet the boy, aside from troublesome leakage about the tube, was perfectly well for over 12 years. Then nephritis showed itself and he soon succumbed. Autopsy disclosed a complete stenosis of the right ureter at the renal end and a congenital atresia of the left ureter near the bladder with a marked atrophy of the left kidney.

Drew in his cases circumvented the cause of the trouble. Wipple and Allen did away with its ill effects at least temporarily without removing the cause, but so far as I have been able to ascertain Mayo's case, Nichols's case, and our case at the Carney Hospital are the only ones in which a successful removal of both cause and effect was possible and was accomplished. The history in brief of these three cases follows:

### CASE REPORTS.

Mayo's Case (personal communication of Dr. E. S. Judd, first assistant surgeon, St. Mary's Hospital, Rochester, Minn.).—Female, married, aged forty-six. Seven years before consulting the Mayos she had passed bloody urine for a few days; at and after that time she had more or less pain in the upper left quadrant of her abdomen, varying somewhat in degree at different times, and shooting through to her back but never extending downward; each year she had one or two spells of bloody micturition; these were usually of only a few days' duration, but seven or eight months before entering St. Mary's she passed bloody urine for seven weeks, became pale, and for the first time thought she would have to give up and go to bed. Since that attack she had been feeling worse. Frequency of micturition had been a constant symptom, at first accompanied by pain, but of late painless. There was general abdominal tenderness and some resistance across upper abdomen, especially to left of epigastrium. Ureteral catheterization showed negative findings on the right; on the left, obstruction in the ureter near the bladder. Urine from the right side negative. At operation the left kidney and left ureter were removed. The kidney was hydronephrotic and the ureter was dilated to the size of the small intestine. It showed a stricture about one inch above the bladder. Recovery.

Nichols's Case.—Male, aged nine. Several days previous to entrance to hospital the child was seized suddenly with general abdominal pain and vomiting; the latter was not a prominent symptom. The pain had gradually grown worse and finally became localized over the appendix region; bowels were constipated. Before examination there was general spasm of the abdominal muscles, voluntary on the left side, both voluntary and involuntary on the right. Temperature 101° F., pulse 104; white count, 18,500. At operation the appendix was found to be normal. A large dilated kidney and a much dilated ureter were removed. There was a contraction of the ureter just below the kidney, and a more marked one (which would just take a fine probe) one-half inch above the bladder. Recovery.

Author's Case.—Male, aged six. One year before admission to hospital the boy had an attack entirely similar to that from which he was suffering at the time of his admission. He was in bed four or five days then. He was well from that time until two days before coming to the hospital, when he began to complain of abdominal pain, sore throat, and malaise. Vomiting followed, and the abdominal pain became much worse and localized itself in the left lumbar region, shooting up the back; no bowel movement for forty-eight hours; never had shown any urinary symptoms of any kind; no muscular spasm of abdominal muscles. Temperature 101.6° F.; pulse 120; white count 16,400. A tender, sausage-shaped mass was palpable to the left of the spinal column above brim of pelvis. Though there was no history of blood-streaked mucus from the rectum, a probable diagnosis of intussusception was made. At operation a moderately large hydronephrotic kidney and a ureter dilated to the size of the small intestine were removed. There was a complete stricture 1½ in. above the bladder. The ureter was atrophied below the point of stricture. Recovery.

### OBSERVATIONS ON DIAGNOSIS AND TREATMENT.

The diagnosis in any case is not a matter of ease. As has been said before, the present wide-spread and skilful use of the cystoscope, of the ureteral catheter, and of the X-ray will result in the relatively frequent recognition of the trouble, at least when it is present in adults; for to-day even unexplained frequency of micturition is sufficient ground for a cystoscopic examination. Lameness in the loin, pain, or an uncomfortable sensation there with some disturbance of urination should rouse our suspicions of a possible hydronephrosis. In children, the question is a more difficult one, and probably a large proportion of the cases will in them still remain undiagnosed. An increase in girth or a bulging in the loin may be the first sign in a child and should always lead to careful examination. Keeping in mind the possibility of the existence of such a pathological entity as congenital stricture of the ureter in its various forms will, I think, be a step in advance.

As to the treatment, the means must fit the case. It is evident that certain cases will require a nephrectomy and an ureterectomy. Nephrostomy may serve as an emergency measure. Paracentesis of the abdominal tumors is mentioned here only to be condemned, and yet Case LI demonstrates that even such a measure may afford at least temporary relief to a patient. Schwarz [5] speaks of the practicability of puncturing from within the bladder the cystiform protrusions of blind-ending ureters, or of excising a portion of their walls. In women this would probably be a relatively easy matter through an operating cystoscope. In men, it would seem to be a matter of considerable technical difficulty. The combined intra- and extraperitoneal method of opening the bladder, advocated and practised by Harrington and C. H. Mayo, would, it seems to me, offer the best method of approach and of applying the necessary operative procedures to intravesical protrusions. In certain cases of cystic dilatation of the ureter just behind the bladder, ureterocystostomy might be practised.[14] Perhaps, even here, removal of the kidney and ureter would prove wiser and safer.

It is probable that the future will see many more pre-operative diagnoses of the condition.

### ABSTRACT OF CASES.

#### *A. Cases Showing Protrusion into Bladder.*

CASE I.[15]—Female, aged five and a half months, had been ill for 2½ months with vomiting, diarrhœa, and loss of weight as symptoms. Physical examination was negative except for a purulent discharge from her right ear. Autopsy: abdominal organs negative. The right kidney (6 cm. by 3.5 cm.) and the right ureter normal. The left kidney (8 cm. by 4.5 cm.) shows a dilated pelvis filled with cloudy fluid; the kidney substance shows marked atrophy and small areas of infection. Arising close together from a common pelvis are two ureters united by fibrous tissue; both dilated and filled with cloudy fluid. The anterior one averages 3.5 cm. in diameter, and the posterior 2.5 cm. The walls are thin and delicate. Both ureters run together till bladder wall is reached; the anterior passes through the wall and opens normally into the bladder; its dilatation ceases when it enters the bladder wall. A little below and to the outer side of this the smaller, posterior ureter penetrates the bladder wall and opens into a blind cystiform protrusion into the lumen of the bladder. The protrusion is 2 cm. in circumference and "is produced by an uplifting of the tissue of the inner wall of the bladder." It is filled with cloudy fluid, and does not connect with the bladder cavity or with that of the other ureter. When filled, it obstructs the opening of the other ureter of the same side and thus produced the hydronephrosis. Adrenals normal.

CASE II (Burckhard[16]).—Male, aged sixty-two, died of pneumonia. Double hydronephrosis, more marked on right. Both ureters open into bladder by very small openings at the tip of protrusions. Both ureters dilated just above bladder and just before reaching pelvis. Both ureters thickened.

Case III (Davies-Colley[17]).—Female, aged eighteen months. Left ureter shows a finger-like protrusion 1 in. long into lumen of bladder. Left ureter dilated to size of finger. Left kidney pyonephrotic (infection probably due to an attack of measles).

Case IV (Beach[18]).—Female, aged five months. Well up to six weeks before death. Then trouble with urination began. Death in four days. Left kidney and ureter normal. The right kidney showed at its lower end an apple-sized cyst from which ran a supernumerary ureter opening by a very small aperture into a blind cystiform protrusion into lumen of bladder.

Case V (Ogle[19]).—Pelvis of left kidney widely dilated; the renal substance deficient. The left ureter dilated to size of pencil. Into the bladder projects a cyst the size of a small pea. This cyst communicates by bristle-like openings both with the lumen of the bladder and with the dilated ureter.

Case VI (Johnson[20]).—Female, aged ten days. The right kidney enlarged and its pelvis distended; the right ureter dilated and curving. Left kidney, though imperfectly divided into two kidneys, has a continuous capsule. It has two ureters, both much dilated and tortuous; they join 1 cm. above point of entrance into bladder. Acute cystitis. The right vesico-ureteral orifice normal. "From the corresponding point on left side a protrusion covered with vesical mucous membrane extends downward, gradually increasing in size and ending in a bulbous enlargement, which with the parts in their natural position occupied the whole length of the dilated urethral canal and protruded externally between the labia. On its posterior surface the bulbous enlargement is attached to the floor of the urethra nearly as far as the orifice. On its right side the enlargement presents a long rent opening into the hollow interior, from which a probe can be passed upward into the ureter." The vagina, uterus, uterine appendages, and intestine were normal. Rupture of the bulbous enlargement occurred on the sixth day and child died of the subsequent infection.

Case VII (Young[21]).—Male, aged forty-nine. Bloody micturition several times fourteen months before. No blood in urine since, though he has complained of frequency of micturition. Cystoscope showed a cyst, size of grape, at end of left ureter; pin-point left ureteral opening; the cyst swelled out every twenty seconds, carrying with it the ureteral orifice from which a fine stream came. As long as urine flowed, the cyst would remain dilated and would then collapse into a mass of wrinkled mucous membrane.

Case VIII (Tangl[4]).—Female, aged sixty-seven. Right kidney and ureter normal; chronic interstitial nephritis of left kidney; congenital atrophy of left kidney; blind cyst-like projection of end of left ureter into bladder; gradual widening of lower section of left ureter; uterus bilocularis unicollis. From the posterior surface of left kidney comes a projection with three entirely distinct arms (4 mm. broad and 3 cm. long) which merge into a common cavity (the true pelvis, 14 mm. broad), the lower end of which is continuous with the ureter (6 mm. wide). The part of the ureter just above the bladder gradually widens and passes directly into a pouch beneath the mucous membrane of the bladder, projecting into the vesical cavity. The cyst in the bladder, when full, is spherical and of the size of a walnut. It contains yellowish-brown, muddy, thin fluid and is situated much lower and nearer the urethra than is the opening of the right ureter.

CASE IX (Boström[4]).—Description of a pathological specimen. A cystiform projection of right ureter into bladder; left ureteral opening normal; no right ureteral opening. In its place is a finger-like projection of mucous membrane, 6.5 cm. long, flaccid in its empty state, pear-shaped when completely distended; its greatest transverse diameter is 5 cm., and this is gradually reduced in the direction of the tip which is 5 mm. broad. It has no communication with the bladder. Its inner lining of mucous membrane is directly continuous with that of the right ureter, and the ureter opens widely into the cyst-like protrusion. The ureteral wall is somewhat thickened and the opening into the cyst is abnormally widened (12 mm.). The specimen does not show the upper part of the ureter and the kidney. It must be assumed that the much dilated ureter and the kidney were destroyed by the highest grade of hydronephrotic atrophy. The bladder was large and showed muscular hypertrophy.

CASE X (Otto[4]).—Six months' fœtus. Large abdominal hernia; malformation of cloaca and pelvis; liver without gall-bladder; small intestine ends in the cloaca; both kidneys without suprarenals; absence of right ureter; left ureter dilated, tortuous, and ends in a blind sac in that portion of the cloaca which would correspond to the urinary bladder.

CASE XI (Boström[4]).—Male, aged twelve. Apparently healthy up to the age of eleven and a half; then began to complain of urinary symptoms and to increase in girth; urination increased in frequency and in difficulty; strangury; the boy was well nourished. Abdomen, particularly between symphysis and navel, was considerably distended, and there was a non-sensitive tumor, dull to percussion, lying close beneath the abdominal wall between the symphysis and navel; the tumor was kidney-shaped and could be moved easily to the right or left. At the pelvic end it was fixed; the upper end was free; surface smooth; tensely elastic; on fixation undoubtedly fluctuant. There was more resistance in the right than in the left loin, though a distinct tumor could not be felt there. In the left lumbar region a long, sausage-shaped tumor with its long axis lying transversely could be rolled under the finger. It was fluctuant and was lying partially on the spinal column and behind the intestine. Urine showed a specific gravity of 1007, was acid, clear, with a trace of albumin and no sediment. Puncture of the tumor between the navel and the symphysis gave a watery, clear, light-yellow acid fluid without albumin or sugar; did not coagulate on standing; it contained no succinic acid and about as much chlorides as urine. The diagnosis lay between hydronephrosis and an echinococcus cyst. Double puncture of the two abdominal tumors was made with the hope of securing adhesion formation and a later opportunity of opening the tumors. Death from meteorism (?) (peritonitis). Autopsy showed congenital closure of the left ureter with cyst-like projection of the vesical mucous membrane. Enormous dilatation of the left ureter. Marked atrophy and abnormal position of the left kidney; renal blood-vessels abnormal. Marked hydronephrosis of the right kidney. Enormous dilatation of the bladder. The projecting vesical mucous membrane through its tense filling with urine completely closed the urethral opening so that urination was quite impossible.

Case XII (Rott[4]).—Male, aged fifty-two, dead of phthisis. Right kidney absent with its pelvis and vessels. Near the side of the fourth lumbar vertebra began the right ureter which increased distinctly in volume as it went downward; in places it appeared lobulated. In the right vesicorectal space it was crossed by the vas deferens, with which it communicated by a very fine opening. Below this point the ureter reached a diameter of over 2 cm., but was narrowed at certain places by shallow constrictions. It reached the base of the bladder at the normal place, but had no opening into it. In place of the normal opening was a half spherical cystiform protrusion into the bladder lumen; its base reached to the caput gallinaginis; the protrusion had a diameter of 2 cm. and the ureter opened into it by a gradually decreasing lumen. The portion of the ureter below the vas deferens and the protrusion formed an elastic fluctuating cyst with walls under high tension.

Case XIII (Lechler[4]).—Female, aged three months. Shrieked with every urination. Labia majora pressed apart by a cyst (size of dove's egg); it was very tense and appeared to come through the vaginal opening. It looked like the bladder. It was replaced, but on the third day appeared again; urine suddenly shot out from it. Death in 28 hours. Right kidney and right ureter normal; left kidney was twice normal size and the upper half was cystically dilated. One ureter left the kidney in the usual way; from the cystic dilatation came a second ureter, which was widely dilated, shaped like a hen's intestine, and ran tortuously through cellular tissue down into the pelvis. Base and body of the bladder normal; vesical neck somewhat lengthened; urethra wanting; the neck of the bladder opened directly into the outer air. The bladder was then opened through its anterior wall and there appeared a "second bladder" which was the dilated blind end of the ureter from the cystic upper portion of the left kidney.

Case XIV (Boström[4]).—Pathological specimen from the body of a 23-weeks-old girl. Shortly after birth there appeared a rather well-marked abdominal swelling which increased in size and which four months before death presented as a three-lobed tumor, one lobe in the centre joined with one in either kidney region. The median one rose out of the pelvis to the level of the navel; it seemed to be connected with the bladder. The child for days would pass no urine. When urine did come, it was in large amounts but showed nothing striking. Autopsy showed reduplication of both ureters; embryonic closure of one ureter with cystiform projection of vesical mucous membrane, which blocked the internal urethral opening and compressed the other ureteral openings; double hydronephrosis; marked dilatation and muscular hypertrophy of the bladder.

Case XV (Lilienfeld[4]).—Pathological specimen from body of a male, aged sixty-five, dead of typhoid. At upper end of right kidney is a structure which is assumed to be a degeneration of the parenchyma. From the pelvis (contracted about a stone) of this portion of the kidney ran a ureter which proceeded with the normal ureter (joined to it by connective tissue), penetrated the bladder somewhat below it, and ended in a cystiform protrusion (filled with clear liquid) into the bladder lumen.

Case XVI (Heller[4]).—Female, aged seventy-nine, dead of pneumonia. Autopsy showed an enormous, fluctuant cyst, arising from the right side and filling the whole abdominal cavity; scanty remnants of renal substance in the wall of the cyst; in bottom of sac was an opening which led into a dilated (2–3 cm. wide) ureter with a thick, flabby wall; the ureter ran with many twistings and turnings down to the bladder and ended blindly in a cystiform protrusion into the vesical lumen. On the anterior surface of the cyst was a flattened kidney, from the pelvis of which a ureter led down and opened into the bladder above the other ureter of the same side. On the left, the otherwise normal kidney was separated into an upper and lower half, each with a fairly normal pelvis; from each pelvis ran a ureter; these joined just before reaching the bladder and opened into it by a common trunk.

Case XVII (Geerdts[4]).—Female, three weeks old. Child had complained for eight days of a diarrhœa and abdominal distention. Suddenly a tumor appeared at the vaginal opening. It came through the urethra and could be pressed back through it. A plastic operation was done on the urethra, but the tumor soon appeared again and finally sloughed. The child died of what seemed to be general peritonitis. Autopsy showed a general peritonitis; right kidney and ureter normal; on the left side a double renal pelvis; both dilated, especially the upper, which was filled with pus; from the lower ran a normal ureter which opened normally into the bladder; from the upper pelvis a dilated ureter ran down and ended in the bladder in a cystiform protrusion, which had finally passed through the urethra and formed the tumor mentioned above.

### *B. Cases Showing no Protrusion into Bladder.*

Case XVIII (Welz[6]).—Child, aged two and a half months. Ill four weeks. For the first two weeks had convulsions; then followed a week of quiet; almost continual convulsions since. No vomiting; stools yellow and thin; abdomen somewhat distended but soft. Autopsy showed a lobulated left kidney; capsule easily removed; right kidney somewhat larger; both ureters dilated, the right more than the left; rather small, somewhat thickened bladder with pale mucous membrane; opening of right ureter into bladder obliterated; hydronephrosis of both kidneys; internal hydrocephalus.

Case XIX (Meschede[4]).—Left kidney absent. Right enlarged more than half. In the bladder the ureteral orifice was present only on right side. Where the left one should have been was only a dimple in the mucous membrane. On the outer bladder wall, corresponding to the location of the dimple within, was an embossed cyst the size of an egg, from the upper part of which ran a hollow cord which communicated with the cyst at its lower end, but which ended blindly above in the subperitoneal tissue at a point a finger's breadth below where left kidney should have been. Yellowish fluid in the cyst.

Case XX (Vignier[4]).—Atresia ani; small kidneys and dilated ureter[illegible] Left kidney larger than right; the left ureter goes to the bladder without opening into it; the right ureter does not connect with the bladder; its lower end narrows suddenly and connects with the rectal ampulla by an opening as fine as a hair.

Case XXI (Otto[4]).—Monster. Abdominal hernia, which includes the liver, gall-bladder, stomach, pancreas, spleen, and small intestine. Behind the hernia were two kidneys; left kidney smaller; left ureter absent; right ureter ends in cloacal wall.

Case XXII (Otto[4]).—Monster. Abdominal hernia; spina bifida; cloaca; two suprarenals; wide, tortuous ureters which end in blind cysts not connecting with the bladder. Uterus, tubes, and ovaries reduplicated.

Case XXIII (Montmollin[4]).—Full-term child. Arrest of development of intestine and urinary organs; atresia ani; large intestine ends in blind sac at level of promontory; similar ending of left ureter; right ureter connected with bladder by a fibrous cord.

Case XXIV (Wipple[8]).—Female, aged twenty-five. At fourteen years of age symptoms of right-sided hydronephrosis appeared, which indicated nephrotomy. All the urine flowed through the operative fistula; no urine came from bladder. In her twenty-fifth year, severe pain and tumor formation in region of left kidney; incision, evacuation of pus, and later extirpation of the left hydronephrotic sac; left kidney atrophied. Recovery. There must have been congenital strictures of both ureters.

Case XXV.[6]—Alcohol preparation of eight months' fœtus, dead of suffocation. Beginning double hydronephrosis due to congenital atresia of ureters at vesical openings. Slight dilatation of both ureters.

Case XXVI (Weigert[8]).—Specimen showing the abdominal and pelvic organs of a new-born, full-term child. Perineum included in the specimen; no anal opening; rectum and large intestine much dilated; small intestine, liver, biliary passages, and stomach normal; left ureter opens into bladder normally; it is 14 cm. long, is dilated, and opens above into a dilated pelvis; calyces distended, papillæ flattened; otherwise, kidney and suprarenal normal. On the right side, no vesical opening of the ureter. The rectum opens into urethra near caput gallinaginis. In place of right kidney is a conglomeration of cysts to which go vessels from the aorta forming a sort of hilus; from the conglomeration of cysts goes out a ureter which for a distance of 2.4 cm. has a visible lumen, and is then continued as a solid cord to the posterior surface of the bladder, where it is lost. No right seminal vesicle.

Case XXVII (Mutach[8]).—Male; died thirty hours after birth. Tumor (size of fist) in right kidney region; it extended toward median line and down into pelvis. Right kidney showed marked cystic degeneration; cysts were thin walled and contained clear fluid. Opening of right ureter into bladder had a circumference of 2 cm., but the ureter narrowed as it extended upward and was obliterated 5.5 cm. from kidney. It soon again showed a lumen and retained it till it reached the hilus and communicated by a minute opening with a calyx. The left kidney was simply a conglomeration of cysts containing clear fluid. The left ureter had a normal vesical opening, but was completely obliterated 2 cm. above it, where it formed a fibrous cord, which, near the kidney, again took on a lumen which could be traced with a sound only to the hilus. Closer examination proved that it connected with a calyx as did the right ureter.

Case XXVIII (Haviland[3]).—Male, aged eighteen. Well up to 12 years of age when he fell 20–30 feet. He seemed to be only shaken up and a quick recovery followed. Since then, however, he had had painful urinary incontinence; blood and pus in urine; autopsy showed left kidney degenerated into a number of sacs with contents resembling pus. Each sac was separated from its neighbor by a distinct membrane. An outlet from these sacs was not to be found. The left ureter was atrophied, impermeable, and surrounded by a thick layer of fat. The right kidney was pale and hypertrophied, and had at each end a cavity containing pus. The right ureter was much dilated and surrounded by fat and many indurated lymph-vessels.

Case XXIX (Osterloh[4]).—Girl, new-born. Double ureter on left side. The left lower ureter normal; the left upper ureter dilated and ended blind in a cyst behind the bladder. Upper half of left kidney was hydronephrotic.

Case XXX (Stoltz[4]).—Right side of uterus well developed; the left horn had tube and ovary but was atrophied. The right kidney had two ureters; the upper ran from a sort of thick-walled cyst downward to end blindly in the bladder wall on the left side. The lower ureter was entirely normal. There was no trace of left kidney.

Case XXXI (Teyssèdre[8]).—Male, aged one and a half years, dead of measles. Congenital absence of right kidney; right suprarenal present; atrophy of right renal vessels; both ureterovesical orifices normal; right ureter permeable from bladder to level of iliac fossa; from there to the place where right kidney should be it is only a fibrous cord. The other genito-urinary organs are normal.

Case XXXII (Ferrand[22]).—Male, aged four and a half years, dead of diphtheria. Left kidney absent; left pelvis represented by a closed cyst, from the outer wall of which a dilated ureter ran down to a cystiform dilatation outside the posterior bladder wall.

Case XXXIII (Fenwick[23]).—Specimen from a male, aged sixty, dead of cerebral hemorrhage. Right kidney enlarged but healthy; left kidney represented by a stiff-walled, multilocular sac of the size of a goose-egg and containing a thin, white, opaque fluid glistening with cholesterin crystals. Wall of cyst is calcified. Left ureter is an impervious cord; no left ureterovesical opening in bladder.

Case XXXIV (Pelissier[24]).—Male, aged twelve. For years abdominal pain radiating into the loins; occasional inability to urinate, and finally loss of control of urination. The abdominal pain grew worse, fever began, and boy's condition became hazardous. Abdomen distended and tender. Below was a central dull area reaching to the umbilicus; flanks clear; fluctuating tumor parallel to right groin. The X-ray showed a vesical stone which was removed suprapubically; drainage; no improvement; death. Autopsy showed abdominal organs normal; right ureter distended to size of thumb; right kidney enlarged; left ureter size of small intestine; both kidneys were simply pockets of pyo-uronephrosis parenchyma practically destroyed. Ureters could be catheterized only in a retrograde way and then only with filiforms, because of punctiform openings (like openings of lachrymal ducts) into bladder. This was evidently a congenital deformity which probably began in infancy and was progressive; infection came through formation of stone in bladder.

Case XXXV (Drew[25]).—Female, aged thirty-four. Tumor in left loin for four years; it gradually increased in size, and pain as well as frequency of urination were accompanying symptoms. Operation: one pint of urinous fluid from renal pelvis; renal substance considerably damaged, but the organ was obviously still good; stricture (¼ in. long) of ureter just as it entered pelvis. The stricture was not cicatricial but evidently congenital; it would just admit a probe. The ureter entered the hydronephrotic pelvis ¾ in. above its level: pyelo-ureteroplasty resulted in cure.

Case XXXVI (Drew[25]).—Female, aged fifty. Tumor in left abdomen for 1¾ years. With its gradual increase in size pain began, and there was increased frequency of micturition. Operation: 1¼ pints of urinous fluid from the pelvis. The kidney substance was not damaged. The upper four inches of ureter was much narrower than normal; orifice would just take a probe. Ureteral orifice enlarged by a pyelo-ureteroplasty. Marked improvement four months after operation.

Case XXXVII (Corsy[26]).—Autopsy subject, dead of tuberculosis. Right kidney was normal, except that pelvis is slightly distended with a clear liquid that cannot be forced out; four cm. below the pelvis the ureter shows a stricture which diminishes the ureteral calibre by one-half. On the left side there is no hydronephrosis, but at the same level as on the other side there is an ureteral stricture which is not so well marked. Pathological stricture is out of the question; there is no elbowing, and no aberrant vessel.

Case XXXVIII (Shield[27]).—Male, aged seven months, complained of diarrhœa and vomiting for three weeks. On the right side completely filling the loin was a large mass, firmly fixed, apparently solid and palpable by rectum. Death. Autopsy showed the mass to be an enlarged right kidney of the size of a cocoanut. Right ureter ended in a fibrous cord; no opening into bladder; upper part of ureter much enlarged (2 inches in circumference); it coiled downward into the pelvis, which is almost completely filled by it; it pressed on the rectum and left ureter, which with the left kidney is enlarged and hyperæmic. The disorganized right kidney and the right ureter were filled with yellow pus, the source of which was unknown.

Case XXXIX (Auscher[28]).—Male, aged one and a half years, dead of measles. Left kidney slightly enlarged; right kidney of the size of a bean, had arteries going to it. In the bladder there was nothing abnormal. In the pelvis and iliac fossa the right ureter was normal but slightly smaller than the left; just as it clears the fossa it diminishes rapidly in size and runs as a thin impermeable cord to the rudimentary right kidney. Testicles, vas deferens, etc., normal.

Case XL (Handford[29]).—Male, aged nineteen. Great foot-ball player. He was seized suddenly with acute chorea and was sent to an asylum; death in fourth week of illness. Autopsy showed a much enlarged left kidney; the right kidney was represented by a cyst (size of a filbert). The right ureter, dilated to the size of the small intestine, contained clear fluid. Both ureteral openings were present in bladder, but a probe passed into the right ureter met an impassable obstruction ½ inch above opening; right adrenal normal; right renal vessels atrophied but normal in origin and course.

Case XLI (Pitt[30]).—Male, aged twenty-two, killed by train. Left kidney distended and its pelvis considerably enlarged; the left ureter at its junction with the pelvis was very small and would just take a probe the size of a No. 2 catheter. The kidney structure was practically normal.

Case XLII (Ord[31]).—Male, aged one year, dead of anæmia; hydronephrosis (side not mentioned) due to stricture at point of exit of ureter from renal pelvis; kidney dilated and contained urine turbid with pus-cells.

Case XLIII (Pollock[32]).—Male, aged sixty-two. Twenty years before he had had dropsy and general anasarca. Except for dizziness he had been well since then till very recently, when attacks of suppression of urine began; death from uræmia; autopsy showed an atrophic, cystic left kidney; the left ureter is impervious throughout its whole course and has no opening in the bladder; right kidney large and healthy. The right ureter was plugged at its lower end by a calculus.

Case XLIV (Sainsbury[33]).—Female, aged thirty-four, dead of uræmia. Right kidney shows advanced nephritis. Right ureter patent; left kidney represented by a pyonephrotic sac filled with a soft, thick paste; left ureter patent in upper two-thirds, but calibre was lessened. Two small, valve-like flaps at the same level effectually closed the outlet of the pelvis into the ureter; lower third of the ureter impermeable; no opening into bladder; the valves and the impermeability congenital. In this case the impermeability of the lower third of the ureter was a potential rather than an actual cause of obstruction.

Case XLV (Pitt[34]).—Young adult. The left kidney was hypertrophied; the right kidney only half normal size; thick, dense stricture of right ureter about ½ inch from renal pelvis.

Case XLVI (Penrose[35]).—Male, aged twenty-five. There was an absence of upper two-thirds of left ureter, and the left kidney was very small and cystic.

Case XLVII (Allen and Parker[36]).—Male, aged two and a half years, seen in May, 1889, with a markedly enlarged abdomen due to a collection of fluid filling the whole right side. Operation. A greatly distended kidney held the collection of fluid. An attempt to shell it out had to be given up because the child was in poor condition. Drainage. Patient recovered from the operation. For a few weeks he passed a few drachms of urine *per urethram.* After this time all passage of urine by the natural channel ceased, and up to the time of his death (February, 1902) he passed no urine whatever except through the operative opening in his side. Apart from the annoyance of wearing a silver tube in the opening which discharged constantly into a rubber bag, and apart from the fact that no satisfactory way could be devised for collecting the urine at night, the boy was perfectly well, went to school, etc., and appeared to be in normal health till June, 1900. Then the tube began to trouble him greatly and he was much annoyed by leakage of urine around it. Under ether, the opening was enlarged. He was not seen again till January, 1902. Then he looked pale, had had a severe hemorrhage from his nose and a considerable discharge of blood from his side. He showed slight œdema of his face and legs and an enlarged heart. The hemorrhage from the kidney continued and the boy died of uræmia in February, 1902. Autopsy showed complete stenosis of right ureter at renal end; slight dilatation of right ureter, associated with valve-like folds in the mucosa. Hemorrhagic pyelonephritis with marked distention of the right kidney; fistula between lower end of right renal pelvis and abdominal wall; hypertrophy of right kidney with acute and chronic nephritis and pressure atrophy; the left ureter lobulated and looking like a string of sausages, bow-shaped, dilated (3-4 cm. in diameter), and nearly filled with 200 c.c. of clear, amber-colored fluid which flows freely from one part to another; the ureter extends to the bladder but does not communicate with it. On section the walls are thin, and valve-like folds are seen narrowing its lumen in places. Mucosa normal in appearance; left renal pelvis slightly enlarged and envelopes about two-thirds of circumference of kidney. It communicates only with a single calyx. Left kidney shows chronic interstitial nephritis with marked atrophy.

CASE XLVIII (Förster[4]).—Still-born male fœtus (seven to eight months). Left kidney and ureter absent; left suprarenal (larger than the right) lay in its usual place; right kidney, somewhat larger than normal, was in the usual position; its calyces and pelvis somewhat dilated; no suggestion of double kidney; the right ureter is much dilated and runs tortuously beneath the lower end of the colon to open in the left side of the bladder at the exact place where, under normal condition, the left ureter would open; the orifice is very narrow and takes the smallest probe. Where the right ureter should open normally there was no trace of an opening.

CASE XLIX (Billard[37]).—Child, aged one month. Huge hydronephrosis; the left ureter terminates normally in bladder, but above forms two thin impermeable strings joined to the renal pelvis by a series of cords.

CASE L (Thurmann[38]).—Large congenital hydronephrosis due to an entirely impermeable ureter.

Case LI (Cooper–Rose[3]).—Female, aged twenty-eight years. Under treatment for thirteen years for supposed ovarian tumor. When she was fifteen, an indistinctly fluctuant tumor (size of fist) was felt in region of left ovary. For two years before that time there was occasional hæmaturia; after the discovery of the tumor, frequent attacks of hæmaturia. The tumor grew rapidly and in three years occupied the whole left side of the lower abdomen; much pus and blood in urine; for eleven years her general condition was but little disturbed; then distention of the abdomen and pain began, and a fluctuating area made its appearance between the navel and the crest of the left ilium. A needle was introduced and seven pints of hæmo-purulent fluid containing no urinary salts was withdrawn. Following this the tumor grew much smaller (size of fist), but the fistula remained open and discharged pus. Death two years later. Autopsy showed a large cystic tumor (6 in. by 3 in.), occupying place of left kidney; no kidney substance; cyst contained blood and pus. The left ureter was a solid cord. The right kidney showed parenchymatous nephritis.

Case LII (Mayo[39]).—Female, aged forty. For seventeen years patient had frequent attacks of rather typical renal colic on left side; the usual pain was complained of; blood and pus in urine; fever and chills at times. Attacks have increased in frequency of late; left kidney area tender; tenderness in left iliac fossa; right kidney palpable; cystoscopic examination showed "roughening in left ureter; urine coming from that side." X-ray (collargol plate) disclosed "obstruction of left ureter near bladder; hydro-ureter." Operation. Hydronephrosis with stone in pelvis of kidney; stricture of ureter ("probably congenital") ¾ in. above the bladder; kidney and ureter removed; ureter dilated to size of small intestine. Recovery.

Case LIII (Mayo[40]).—Male, aged twenty-four. For five years patient had frequent urination day and night; smarting and pain in penis before and after urination; pus in urine for some months; some years before some blood in urine; three attempts (the last under ether) failed to catheterize the entire left ureter. Operation: nephrectomy for tuberculous pyonephritis; stricture of left ureter 1½ in. below kidney; it was almost complete; the ureter below it looked healthy. Recovery.

Cases LIV, LV and LVI will be found in text.

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# PRIMARY (CONGENITAL) HYDRONEPHROSIS.

## REPORT OF A CASE WITH REMARKS ON THE TREATMENT AND PATHOLOGY.

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Congenital, or speaking more correctly, primary hydronephrosis is not what may be termed infrequent, while the acquired form is very rare in children. The latter may be the result of ureteral compression by a malignant tumor, by adhesions resulting from a tuberculous peritonitis, or an hydatid cyst of the under surface of the liver. Uric acid sand has been said to be the most frequent factor, as it accumulates at either the upper or lower ureteral orifice, causing obstruction of the lumen. The affection is apt to be bilateral, and the hydronephrosis usually is only incomplete and partial. The renal enlargement is not excessive. Dilatations occur in the ureter, but the renal pelvis may not of necessity become dilated. It may occasionally result from a ren mobilis, just as occurs in the adult.

The primary or congenital type is nearly always due to malformation of the ureter, such as absence or stricture of the tube, but sometimes the pathogenesis remains very obscure, exploration of the ureter showing it to be apparently perfectly normal.

The case that I have to report occurred in a girl, two years and eight months of age, who was referred to me in November, 1903. There was little of interest in the past history excepting that she had always been a rather weakly child. About seven months before seeing the patient, her mother had noticed some distention of the abdomen, and this had gradually increased. At the same time the child complained of pain each time the bowels moved, and there was some diarrhœa. The patient was referred to me with a diagnosis of probable tuberculous peritonitis.

Examination showed that the bony structures and muscular tissue were fairly well developed, but that of late the child had been losing flesh. The abdomen was greatly distended and by inspection it was evident that the left half was decidedly more so than the right. By palpation a tumor could be distinctly made out protruding from under the left costal border and extending towards the middle line nearly to the umbilicus. The fingers could be made to enter between the lower pole of the growth and the iliac bone. The surface was smooth and uniform, the tumor was immovable but showed slight synchronous movements with the respiration. By pressure with the hand some gurgling could be elicited over the surface, showing that some intestinal coils were present between the growth and the anterior abdominal wall. The tumor felt quite hard, fluctuation could not be made distinctly evident, but a liquid thrill was obtained by tapping the side of the abdomen with the finger. The right half of the abdomen was somewhat tympanitic, while percussion showed that there was a uniform dulness over the entire extent of the growth.

The urine was voided in sufficient quantity, was a light yellow in color, acid in reaction, and microscopically presented nothing abnormal.

The diagnosis lay between a malignant renal growth and hydronephrosis. The child was placed under observation for several weeks, but no change occurred, and given the thrill obtained by tapping the growth with the finger, it was evident that fluid was present, so that a diagnosis of primary hydronephrosis was made.

I would also say that the temperature was at no time raised and that the urine, which was carefully followed, never diminished in amount and never presented any pathologic products during the several weeks that the child was under observation.

Operation was advised and accepted and was performed on December 27, 1903. An incision, beginning at the external border of the spinal muscle mass, was carried from the tenth rib downwards and transversely to the iliac crest; the exposed kidney then protruded into the wound and distinct fluctuation was evident. An incision into the cyst gave exit to 1300 c.c. of fluid (some more of which was lost). It was a straw-colored, slightly cloudy liquid which, upon examination, showed a large amount of albumin and some urea.

After the liquid had been evacuated, the sac collapsed and could then be drawn out through the wound to a certain extent, but it was very adherent in the region of the upper pole and towards the vertebral column. When it had been completely freed after a rather difficult dissection, it was found that the pedicle was very atrophied, the renal vessels having almost disappeared, while a stricture was found in the ureter about 5 c.c. below its junction with the renal pelvis, which completely occluded its lumen. The wound was sutured excepting at its upper angle, where a cigarette drain was inserted.

On the following day the temperature was normal, the pulse 101, and the general condition good. The quantity of urine passed in 24 hours amounted to 800 c.c., and analysis showed that it was exactly as before the operation.

The child made an uninterrupted recovery in spite of an intercurrent attack of bronchitis, and was discharged three weeks after the operation. I saw the patient in May, 1908, consequently four years and a half after the operation, at which time she was a well-developed girl and had enjoyed good health ever since the interference.

Examination of the cyst showed that its walls varied from 4 to 7 mm. in thickness, while at the anterior aspect of the lower pole its thickness reached its maximum. Microscopic examination of this part of the sac showed, in the first place, a large amount of connective-tissue growth. At various points a large number of uriniferous canals were found, whose epithelium only took the stain slightly and most of it had desquamated. The nuclei did not stain at all and the uriniferous canals were choked by the shedding of the epithelium. No normal glomeruli could be detected, but their remnants were present. Evidences of a capillary circulation were present, but, apparently, the vessels had lost their functions. From this examination it is evident that we have the picture of a severe interstitial nephritis.

In the *Pathological Transactions,* vol. xi, is to be found a very interesting paper by Griffiths, entitled, " The Histological Changes in the Kidney in Hydronephrosis." He does not consider the changes, such as occurred in our case, as a direct result of pressure exerted on the renal calyces, which in turn causes an interstitial overgrowth of connective tissue with a complete disappearance of the uriniferous canals, but he explains the process which leads to such changes in the renal parenchyma in a somewhat different manner. According to his way of thinking, these occur only when the renal pelvis is greatly distended, resulting in a distention and flattening of the renal vessels, which also become contracted by a form of arteritis and endarteritis.

Referring to the stricture of the ureter found in the case reported, I believe that it is more than probable that it had developed before birth and should be considered as a congenital defect. It must have been partially patent for a time at least, and little by little contracted down so as to completely occlude the lumen of the canal and thus gave rise to the complete hydronephrosis. Then, again, the hydronephrosis must have been present for some time on account of the very marked and advanced renal atrophy. It is also quite possible that a dilatation of the renal pelvis had been present since birth, and little by little became more and more distended as the ureteral stricture narrowed down.

The location of the tumor in the left half of the abdomen, extending down to the bony pelvis, might have been either a splenic or renal growth, but that it was retroperitoneal was made evident by the presence of a few intestinal coils between the tumor and the anterior abdominal wall. Since a thrill without any evident fluctuation could be elicited, it was evident that the contents were fluid, and, therefore, a malignant growth could be practically eliminated.

In female children a large primary hydronephrosis might be mistaken for an ovarian cystoma, but a differential diagnosis may be readily arrived at from the fact that when arising in the ovary the cyst, as it develops, pushes the intestine to one side and the coils are never found between the growth and the anterior abdominal wall. Then, again, rectal or vaginal examination will make the diagnosis of ovarian cyst certain. The contents of a hydronephrotic cyst are distinguished from those coming from an ovarian cystoma by the larger amount of urea they contain. It is quite true that urea may be absent in the fluid from a hydronephrosis, when atrophy of the renal parenchyma has reached such an extent that no normal uriniferous canals are present.

Of other renal growths an echinococcus cyst is the most likely to cause confusion, but in these cases an exploratory puncture will reveal the true nature of the affection.

Malignant disease of the kidney is not infrequent in children, and the growth may be of such soft consistency as to give rise to pseudofluctuation.

Very frequently a differential diagnosis between a hydronephrosis and a congenital cystic kidney can hardly be made, but in the former one may usually elicit a pronounced fluctuation. Then, again, in the polycystic kidney the growth is almost always noticed from the time of birth. However, an absolute diagnosis may not be reached in many cases, but from a practical standpoint, this is of no great value, because in both, surgical interference is indicated. In typical cases when the hydronephrosis is not due to the closing down of a ureteral stricture, we get many characteristic symptoms, such as the occurrence of renal colic, intermittent polyuria which results in a decrease in the size of the swelling, all of which are sufficiently characteristic to render the diagnosis an easy matter.

Regarding the treatment of primary hydronephrosis opinions vary, but it would seem to me that all liquid tumors require an early operation, provided that the other renal gland is carrying out its normal functions. The polycystic kidney, being usually bilateral, should be left alone. However, the process may involve but one kidney and produce compression symptoms, but it is just in these cases that the true nature of the lesion is not diagnosticated, because the affection is here unilateral. If the other kidney is healthy, nephrectomy may be done, but one should always recall that at a later date the remaining kidney may, and undoubtedly will, undergo the cystic change.

No single operative interference can be applied to primary hydronephrosis in children. If it should be the result of a nephroptosis, fixation of the kidney may alone be required, and, if the functions of secretion are sufficient, some one of the plastic operations on the ureter and renal pelvis will find its indication. If the surgeon is convinced that the diseased kidney possesses no functional value, I believe that nephrectomy should be done when possible, preferably by the extraperitoneal lumbar route. Nevertheless, many operators are not of this opinion and prefer nephrotomy. Küster has reported 11 cases in which he successfully performed nephrotomy for hydronephrosis and only one resulted in a fistula. Mendelsohn and Wagner are of the opinion that it is a mistake to deal with a hydronephrosis other than by nephrotomy. They believe that, in those cases where a good result can be obtained by a simpler interference, nephrectomy is a too severe operation, and is also contraindicated because it should be the endeavor of the surgeon to save every bit of functionally active kidney parenchyma that is possible, not only for the ultimate welfare of the patient, but also to avoid the appearance of uræmia where there is a possibility of some pathologic involvement of the other kidney, which, in some cases, cannot be diagnosticated before the operation.

This opinion is also accepted by Geiss, who, out of 18 cases of hydronephrosis upon which he operated, only twice performed primary nephrectomy and five times secondary nephrectomy. Nephrotomy was done on all the other patients, and in nine of them a complete cure resulted. There was one death after primary nephrectomy.

An exactly diametrically opposed opinion is upheld by Jeannel, who, on both statistics and theoretical conclusions, believes that only in the most infrequent cases can a cure of a large hydronephrotic sac be obtained by nephrotomy, and as secondary nephrectomy is always more difficult than a primary one, as it always has a more unfavorable prognosis, he concludes that, under these circumstances, primary nephrectomy is proper, provided that the remaining kidney is functionally healthy. Von Bergmann is also of this opinion and has performed nephrectomy twenty-one times for hydronephrosis.

Israel and Güterbock take an intermediary position in this question. They advise nephrectomy in long-standing large hydronephroses, in which a very large amount of renal parenchyma has become transformed into a hard fibrous sac. They point out, and correctly so, that fistula arises when the renal parenchyma has been allowed to remain, so that nephrectomy has to be ultimately resorted to to do away with this serious complication.

Referring now to plastic operations, it will be seen that when marked anomalies exist which have caused the development of the hydronephrosis, if they are corrected by a plastic operation the kidney may be saved.

Küster has recorded a case of a thirteen year old boy upon whom a nephrotomy had been done for a left-sided hydronephrosis. A fistula persisted after the operation, which could not be made to close, and, as the right kidney was absent, all the urine was discharged through the fistula. Therefore, Küster first endeavored to reach the ureter through the fistula by the passage of a sound. As this did not succeed, he exposed the anterior aspect of the kidney, which bulged forward, and opened the sac. When the interior of the sac was reached through the incision, the course of the ureter became visible and was found to pass upwards along the posterior wall of the sac for a few centimetres and opened into the renal pelvis by a slit-like orifice. Passing the sound through the ureter, a stricture was reached about 3 centimetres below the sac, which just allowed the passage of the very finest sound. The stenosed portion of the ureter was removed including that portion up to the renal sac, and the lower extremity of the ureter was sutured to the posterior wall of the sac. After a very few hours bloody urine was voided by the bladder and four months later the larger portion of urine was excreted normally. Küster believes that this case is sufficient evidence to show that such instances of hydronephrosis caused by stricture of the ureter may be cured.

Israel obtained a cure of a hydronephrosis in a male child eleven years of age by means of a plastic operation. A well-developed valve in the lower portion of the ureteral orifice opening into the posterior wall of the renal pelvis was found to be the causative factor. This was freed in the middle, both halves were pulled apart, and in the angle of the incision the mucous membrane of the ureter was united by suture with the mucosa of the renal pelvis. On each of the separated halves of the valve the mucosa of the ureter was sutured to the mucosa of the renal pelvis. The latter was left opened and drained and four weeks after the interference the patient was discharged cured.

Morris also reports several cases of plastic operations which were performed for stenosis and valve formations in the ureter, and calls attention to the importance of such operations, particularly when stenosis of the ureter is present. In his opinion, the interferences required are: catheterism of the ureters, colpo-ureterostomy, implantation of the ureter, nephro-ureterectomy and ureterotomy.

Many other successful plastic operations have been performed by Kelley and others, but these have been upon the adult, so no further reference will be made to them.

In discussing the operative treatment of hydronephrosis, it should be recalled that in many cases in children the operation is first indicated for diagnostic purposes and this undoubtedly is quite proper. As to exploratory puncture, attention should be given to the fact that it may give rise to septic peritonitis on account of the escape of the contents of the cyst into the abdominal cavity, and this has occurred in more than one instance. I am aware of 10 case reports where death occurred after exploratory puncture of a hydronephrotic sac and, therefore, believe that this procedure is to be condemned.

The relative frequency of the escape of the cystic contents into the abdominal cavity through an opening so fine as that produced by the needle may be explained from the fact that in many cases the contents are composed of a very thin, urinous fluid.

To sum up the treatment of primary hydronephrosis in children, it may be said that surgical interference is indicated under all circumstances. If a portion of the renal parenchyma can be saved I believe that nephrotomy, followed by drainage, is justifiable, but when the secreting portion of the kidney has been destroyed, primary nephrectomy should be undertaken. It goes without saying that this can only be considered when one is certain that the functional condition of the remaining kidney is perfect. Occasionally, as in the case here reported, much difficulty may be experienced from the presence of numerous, tough adhesions, but by working carefully through a long extraperitoneal incision, such as employed in the case here reported, where plenty of room may be obtained, the operation may usually be carried out to a satisfactory conclusion.

*Pathology.*—Having discussed the treatment, I would now like to consider briefly the question of the pathology of primary hydronephrosis, particularly as encountered in childhood. There is no doubt but that this lesion when encountered in adult life may, in many instances, have a congenital origin, because the conditions found can easily be traced back to an abnormal development at birth. Some writers even go so far as to consider all instances of primary hydronephrosis as a result of some anomaly of the urinary tract having a congenital origin.

The degree of dilatation of the renal pelvis depends entirely upon the extent of the obstruction offered to the flow of urine. If this is of mild degree the dilatation of the renal pelvis will be only moderate. This will then produce a flattening of the papillæ and dilatation of the cortex. A more marked dilatation will cause compression of the cortex, so that the uriniferous canals, as well as the glomeruli, become flattened, and thus atrophy of the latter is not infrequently brought about. All these changes are accompanied by a hypertrophic overgrowth of the connective tissue, and finally the sac may reach such a degree as to contain several litres of fluid.

A hydronephrosis may not always result in this cystic dilatation, for one not infrequently encounters a congenital hydronephrosis combined with cystic degeneration of the kidney. This type, however, is to be distinctly distinguished from a simple primary hydronephrosis. Although the clinical differentiation between these affections is a difficult affair, the pathologic finding is very different and the causative factor is not uniform. Macroscopically cystic degeneration of the kidney differs from a primary hydronephrosis in that the kidney is not transformed into a single large cyst, but is converted into a number of small cysts, varying from the size of a walnut to an apple, while microscopically atresia of the papillæ is found, the cause of which has been supposed to be an intrauterine inflammation. On account of the distention and congestion arising in the uriniferous canals, a cystic enlargement results within them, which then develops into a cystic kidney. On the other hand, cystic transformation of the kidney resulting from a hydronephrosis is merely due to pressure of the pent up urine in the renal pelvis.

Many cases of primary cystic kidney due to an obstruction of the ureter or urethra, which, in the first place, produces a dilatation of the renal pelvis, have been reported. For example, Von Mutach in his paper entitled "Genese der Cystenniere," which appeared in 1895 in *Virchow's Archive,* describes a case of congenital cystic kidney with obstruction of the urethra and a hydronephrotic renal pelvis, and another one in which he found occlusion of the ureters. It is evident from the report of these cases that in the first one a hydronephrosis developed, followed by a transformation of the kidney into a single large sac due to an obstruction in the urethra, while in the second case a so-called congenital cystic kidney developed as a secondary process to the dilatation of the kidney.

If Virchow's theory of intra-uterine inflammation be accepted, it might be possible to find in this the cause of stricture of the ureters, as well as an atresia of the renal papillæ. In those cases where occlusion of the ureters is found accompanied by a congenital cystic kidney with a dilated renal pelvis, one could explain the process as follows: as the result of an intra-uterine inflammatory process, the exact cause of which is not as yet fully explained, an atresia of the ureters occurs which gives rise to distention of the renal pelvis, and then, as a result of the back pressure and ascending extension of the inflammatory process, atresia of the papillæ arises, during the development of which cystic disease of the kidney occurs. It could then be taken for granted that, in those instances in which there is a complete occlusion of the ureter, a hydronephrotic dilatation of the renal pelvis with the above-mentioned resulting lesions is found, which is not in the true sense of the word a congenital cystic kidney. The inflammatory process is confined in the first place to the ureters without having extended to the papillæ.

Other writers attribute the obstruction in the ureter to a disturbance in the development and not to an inflammatory process, while others are of the opinion that the hydronephrosis is the direct causal factor of the cystic kidney. If this be accepted, it remains unexplained why, when a hydronephrosis is present, the renal parenchyma should transform into a cystic sac with atrophy of the kidney structures, because the latter condition is found quite as often when the excretory urinary tract is perfectly normal, so that the reason for its production must still be sought for in other circumstances. Thus, a few writers believe it to be due to some developmental interference, while still others are inclined to assume that these cystic kidneys are nothing less than a cystadenoma.

Referring now to the causes of the production of a primary hydronephrosis, it may be said that occlusion at some point of the excretory urinary tract is only one among many, but there must always be an obstruction to the flow of urine at some point which leads to distention of the renal pelvis, first among these to be mentioned being a partial or complete occlusion of the ureter or urethra. Several cases have been recorded where a partial or complete obstruction of the urethra has resulted in a dilatation of the renal pelvis, which naturally involved both kidneys.

Thus Billard found hydronephrotic changes in a newly-born infant which resulted from an obliteration of the urethra situated just behind the external meatus. A case of a child fourteen days old having complete retention of urine from birth has been reported by Schuchardt; catheterism revealed an obstruction in the urethra which was finally overcome by repeated passage of the catheter. The child had a distended abdomen when born, so that it is evident that a hydronephrosis was at that time present. It died, and autopsy revealed an extreme dilatation of the bladder, ureters, and renal pelves. It is evident from all this that even a mild obstruction of the urethra in the newly-born may in reality be a most serious affair.

Rindfleisch has recorded an interesting case of occlusion of the urethra which resulted in hypertrophy of the bladder and hydronephrosis. The subject was a male child five weeks old who developed pleuritis, but had given no evidence of any symptoms in the urinary tract. Autopsy showed a soft elastic tumor the size of a small pea at the caput gallinaginis. The sinus prostaticus was widely patent, but no opening of the ejaculatory ducts could be found. On the other hand, where these openings should have been there was a dilatation and thickening of the blind end of the spermatic cord and this had caused the swelling of the caput and had displaced the lumen of the urethra so that an occlusion resulted.

That slight stricture of the urethra may have a very unfortunate result is made evident by a case recorded by James, in which an eight-year-old boy suffered for several years with urinary symptoms and finally died in coma. Autopsy showed that the bladder wall was greatly hypertrophied, while the renal pelvis on both sides was greatly distended and all these changes had arisen from a tight phimosis. Mr. D'Arcy Power has also called attention to this cause of hydronephrosis in his book on "The Surgical Diseases of Children."

Schuchardt has attempted to explain these extensive changes in the renal pelvis, as follows: in children he maintains that the muscular structures of the bladder are not sufficiently strong to overcome the increased demands, the voluntary impulse to void urine is not so developed, and consequently the bladder may become readily overdistended with much greater ease than in the adult. Now, since the vesical walls are much thinner than in the adult, the ureteral orifices are relatively large, and the valvular mechanism cannot be accomplished with as great ease as in the adult; consequently, a retention of the urine in the bladder and ureters may easily result, and finally from back pressure dilatation of the renal pelves is brought about.

Far more frequently than stenosis or atresia of the urethra, ureteral anomalies result in dilatation of the renal pelvis followed by all its consequences, and may be unilateral or bilateral. The fact that, in all likelihood, every case of primary hydronephrosis is the result of some congenital defect in the excretory urinary tract, renders it apparent that a hydronephrosis may occur in both kidneys quite as frequently as in one. In the first place, we may find a stenosis of the ureter or some abnormal position, such as torsion or kinks, or a malinsertion of the ureter into the renal pelvis, which results in the well-known valve formations. Then we may have two ureters, all of which may produce retention of the urine with its accompanying dilatation of the renal pelvis.

Relative to atresia of the ureter, a unique case has been put on record by Henoch. In a child six weeks of age a bilateral hydronephrosis was found which was the result of a complete cicatricial closure of both ureters. It is evident that the occlusion was not complete, because the infant voided urine up to the sixth week of life, so that it was assumed that, since the parenchyma of the right kidney was more markedly atrophic than the left one, the closure of the right ureter and the hydronephrosis on the same side was congenital, and as a result of the compensation hypertrophy of the left kidney, its pelvis became the seat of an inflammatory process which caused occlusion of the left ureter, followed by a secondary hydronephrosis.

Foerster has related a case where there was atresia of the rectum and in the place of the left ureter there was a solid cord which ran from a hydronephrotic kidney to the bladder. In this case the obliteration of the ureter can be most probably accounted for by some developmental disturbance and not from an inflammatory process, which may be assumed on account of the presence of another malformation, consisting of a rectal atresia. In a child eighteen months old Gruneberg found a complete occlusion of the ureter at its vesical end which had given rise to a hydronephrosis on the right side.

That partial obstruction of the ureters may give rise to the same results as when this is complete is made evident by three cases of primary hydronephrosis reported by Sudeck; in two a ureteral stricture was found at the renal pelvis end of the duct, and in the third at its entrance into the bladder.

It is still a much discussed question as to how the partial or total atresia of the ureter can be explained by the theory of intra-uterine or postfetal inflammation, resulting in the interference in the development, or by other processes. For example, Klebs believes that this may result in slight adhesion of the epithelial surfaces, which in the embryonal stage come into contact with each other.

English, who has undertaken a large number of careful investigations to ascertain the causes of stenosis and atresia of the ureter, concludes that there are three points of narrowing in the normal ureter, namely, where the canal leaves the renal pelvis, at some distance below this point, and where the ureter passes through the bladder wall. In later writings he compares the occlusions with these normally narrowed points, and finds that there is a surprising sameness of occurrence in the localization of these strictures, particularly when the obliteration is partial. Out of 65 ureteral strictures he found that the process only occurred in three instances in the middle of the ureter, while in 34 others it was present at the upper, and in 28 in the lower end of the ureter. From these facts he concludes that a pathologic stenosis is the result of some disturbance in the development of the physiological narrowings of the ureter.

Several cases have been reported of anomalies in the development of the ureters where there were two ureters, but here the hydronephrosis was only partial.

Wrany has recorded two cases of partial hydronephrosis with a double ureter. In the first one, the enlarged right kidney possessed two pelves, each with its own ureter, and only one of the pelves was dilated. Its ureter opened into the fundus of the bladder opposite to the vesical orifice of its fellow ureter, and where it entered the bladder it was surrounded by two folds, which, in all probability, caused obstruction to the free flow of the urine. The other ureter and renal pelvis on the same side were quite normal. In the second case, the left kidney had three pelves each with its own ureter. The ureters of the two lower pelves united soon after leaving them and showed no anomalous condition; but at the entrance into the bladder of the third ureter a sac formed by two layers of mucous membrane was found which had caused a dilatation of this ureter and its renal pelvis.

In a newly-born girl Osterloh found a double ureter running from the left kidney, the upper one entering behind the bladder into a blind sac, which had caused dilatation of the ureter and its corresponding renal pelvis. Lilienfeld has also recorded a case of double ureter running off from the right kidney; one was perfectly normal, while the second was represented by a diverticulum near its entrance into the bladder. The upper end was also obliterated, and as a result of a hydronephrosis the corresponding portion of the kidney had become destroyed. Zaluski has reported a similar case where one of two ureters belonging to the right kidney had a stenosis and its corresponding renal pelvis was much enlarged.

These cases which are taken haphazard from the literature demonstrate that such a partial hydronephrosis, which is not apt to be found where the kidney has a single ureter, can be traced to two principal conditions, namely, to the deeper opening of one ureter into the bladder, and secondly to the formation of a diverticulum at its vesical entrance. Why the former condition leads to a hydronephrosis and how the development of the diverticulum occurs, English has attempted to explain as follows: when the opening of the ureter into the bladder is too deep, its orifice sags in the region of the vesical sphincter, because the ureter must of necessity penetrate a thicker bladder wall. Consequently, when micturition takes place, compression of the ureter occurs from contraction of the fibres of the detrusor urinæ which results in a closure of that portion of the ureter lying above its vesical orifice. From this there results a retention of urine in the ureter, followed by dilatation of the renal pelvis from back pressure.

As to the formation of a diverticulum, English assumes that in these cases that portion of the ureter lying immediately below the vesical mucosa is wider than that lying in the muscular layer and opens into the bladder by a very narrow orifice in most cases. Thus an obstruction is formed, a distention of the mucous membrane of the ureter situated in the muscular layer of the bladder takes place, which offers only slight resistance, and in this way a vesical diverticulum results.

A peculiar type of hydronephrosis, a so-called intermittent form, characterized by an occasional increase in size of the renal region, is occasionally met with when the ureter becomes kinked. The alternating increase and decrease in size of the renal region is the result of an alternating filling and emptying of the renal pelvis. When the renal pelvis has reached a certain degree of distention, the kink in the ureter is overcome by intrapelvic distention and the urine is discharged through the ureter. Landau has endeavored to explain how an intermittent hydronephrosis finally becomes a permanent one. The urine becomes retained in the renal pelvis when the patient is in an upright position and cannot be eliminated until the bending has been done away with. When this has occurred from pressure of the urine in the overdistended pelvis, the kinking again soon occurs and the renal pelvis again becomes filled. If this process of filling and emptying of the renal pelvis is frequently repeated, the elasticity of the latter becomes affected and more and more urine will be retained, so that, finally, the renal pelvis is so greatly dilated that it involves the ureter. The discharge of urine in the upright position then becomes impossible, and when the patient is lying down it can only occur when the kink in the ureter has been undone, which frequently does not take place. These kinks in the ureter are in many cases a secondary affair, particularly in those cases where they result from a movable kidney, but sometimes they are primary, as the following examples illustrate.

In a male who had been ill with symptoms of hemorrhagic nephritis, Weigert found the right kidney transformed into a cyst the size of a child's head, its walls measuring about 2 mm. thick. From the inner and lower portion of the cyst the ureter passed along the lower surface and then suddenly became bent at a right angle and passed downwards to the bladder, its lumen progressively diminishing. As there was no inflammatory change where the bend occurred, the latter was considered as a congenital defect. Roberts has recorded the case of a male, twenty years of age, who presented symptoms of intermittent hydronephrosis and finally died from uræmia. Both kidneys were found transformed into a sac filled with urinous fluid. The left ureter was stenosed near its upper orifice and entered the renal pelvis at a right angle, so that only forcible pressure on the tumor could produce a straightening out of the ureter and allow the urine to flow through. The right kidney, which was represented by a cyst, possessed two arteries, one lying over the other and coming from the aorta. The upper one, after supplying the suprarenal artery, went to the upper portion of the hilum of the kidney, while the lower one soon after its origin divided into two branches, one of which passed to the hilum and the other downwards to the perirenal fat and crossed the ureter near its upper extremity. The cause of the hydronephrosis of the left kidney was due to a stenosis and bend of the ureter, whereas, on the right side, compression of the ureter by a supernumerary renal artery caused the dilatation of the renal pelvis. As this case teaches, it may happen, although infrequently, that a supernumerary artery may produce hydronephrosis by compression of the ureter. I am only aware of two other similar instances. In one case reported by Küssmaul, the lower of the two arteries crossed the ureter at its point of exit from the renal pelvis and produced a fair amount of compression which resulted in a hydronephrosis. In the second case, reported by Rokitanski, the compression was caused by the renal artery at the upper extremity of the renal hilum, the vessel descending into the lower portion and crossing the ureter, and by compression of the latter hydronephrosis resulted.

Most peculiar are those cases where the ureter is patent and still a hydronephrosis is present. Such cases are occasionally met with, and in all of them a valvular obstruction has been found produced by a fold of the mucosa. Mendelsohn has attempted to explain as a reason for the formation of these valves, an abnormal insertion of the ureter into the renal pelvis, believing that the insertion takes place too high up. As a result of this high attachment, he points out that a portion of the renal pelvis under the point of attachment of the ureter must first become filled with urine before it can make its exit through the ureteral orifice. Consequently, dilatation of the renal pelvis results. By constant filling up of the renal pelvis it becomes pressed against the ureteral walls by the gravity and pressure of the collected urine, thus forming an additional obstruction for the exit of the urine, in other words the mechanism is entirely a valvular one. Pathologists have looked upon this valve formation as congenital and not a secondary process, and as resulting from congenital developmental anomalies. They have been considered as a malformation whose development, according to Klebs's opinion, probably may be looked for at the point of exit of the ureter from the renal pelvis. Küster accounts for the development of these valves by an inflammatory swelling of the mucosa of the renal pelvis, while Simon believes that they must be looked upon as a result and not the cause of the hydronephrosis. He found at autopsy another obstruction in the ureter, which he considered the primary cause of the hydronephrosis, and believes that the development of the valves results from a twist which the kidney undergoes as a result of the distention of its pelvis, so that the pelvic end of the ureter becomes displaced.

Ayrer reports such a case of hydronephrosis, the cause of which was a valve formation in the ureter. The patient, eighteen years old, presented a kidney which had become transformed into a sac, its walls varying from 2 to 3 mm. in thickness and containing about 7 litres of a thick yellow fluid. At the point where the ureter opened into the cyst there was a duplication of the mucous membrane, which protruded into the lumen of the ureter like a valve. There was a kind of bend of the ureter causing a lateral displacement, which was produced by a band of connective tissue accompanying the ureter from its origin to a point about 1.5 cm. below the cyst. Ayrer believed that the latter was the cause of the valve formation. In a female forty years of age in whom a diagnosis of ovarian tumor had been made, Wölfler discovered at operation a hydronephrosis, which was found to be produced by a pocket formed in the cyst wall at a point where the ureter entered into the pelvis and formed a crescentic valve. He also examined the ureters of 100 infants and found, in 20 per cent., at a small distance from the opening of the ureter into the renal pelvis, from one to several folds in the mucous membrane, varying in size from 1 to 5 mm., and he consequently thought that a valve could be formed by adhesion of two such folds. A labiate opening of the right ureter into the renal pelvis had produced a hydronephrosis in a case recorded by Giraud, as no other cause for the production of the latter could be found. Reclus has described a case of bilateral hydronephrosis, in which the ureter on the left side up to the bladder was permeable, presenting no bend or other malformation, while, on the right side, only a few fibrous bands were found which had caused compression and dilatation of the ureter. The bladder and ureter presented no defect. Bernard, in four cases of hydronephrosis in nursing infants, found uric acid sand as the only cause for the lesion and is of the opinion that this may explain the pathology of the development of many cases of hydronephrosis where the cause is vague.

Edes reports several such instances of hydronephrosis, followed by atrophy of the kidney, in children in whom not the slightest obstruction to the flow of urine could be found. In these children during life involuntary micturition occurred, while postmortem showed hypertrophy of the bladder walls and other signs of cystitis. He also found several other examples recorded by others, and he believed that, in these cases, as a [illegible] been frequent contraction of the bladder produced by cystitis, a back pressure took place which brought about dilatation of the ureter and renal pelvis.

Levin and Goldschmidt, in a very interesting contribution published in 1893, in *Virchow's Archive,* entitled "Versuche uber die Beziehungen zwischen Blase, Harnleiter und Nierenbecken," on the strength of several successful experiments in rabbits, assumed that these forms of hydronephrosis in which no obstruction to excretion can be found may be attributed to a return flow of urine from the bladder into the ureter and from here to the kidney pelvis. Up to the time of their studies, it had been supposed that as a result of the oblique opening of the ureter into the bladder, a return flow of urine into the ureter was an impossibility, but these writers have proven experimentally, both by injections of fluid into the bladder and by artificial retention of urine by ligation of the urethra, that an acute reflux of the contents of the bladder can easily be produced. This reflux rushes rapidly into the renal pelvis, at first paralyzing its contractility from the great dilatation of the ureter, and at length produces the most varied abnormal movements of the ureter with the renal pelvis, such as antiperistaltic and spasmodic contractions. This result of their experiments led them to the explanation of cases of hydronephrosis which were produced by an irritation of the kidney, with a constant desire to empty the renal pelvis so that hypertrophy finally results and afterwards dilatation, a theory which would appear to be verified by the cases reported by Edes. On account of the permanent contraction of the bladder and ureter, these authors furthermore concluded that the renal pelvis became filled with urine and from this circumstance became distended.

If we now sum up the causative factors of primary hydronephrosis, one must place at the head of the list certain anomalies of the ureter, and secondly others occurring in the remaining portions of the urinary tract, such as the bladder, prostate, and urethra, which are usually developed during intra-uterine life and, consequently, it may be assumed that all primary hydronephroses have a congenital origin. It is quite true that

English claims that the obstruction in the ureter, such as found in adults, is never present to the same extent at birth, but that, on the contrary, certain changes take place in them from which occlusion results. However, the type of obstruction is probably the same at birth, only it is necessary that other factors should intervene to cause retention of the urine, otherwise it would be impossible to understand why in one case these anomalies should result in a hydronephrosis, while in other cases a perfectly normal kidney is found, although these anomalies are present in some portion of the urinary tract.

# RECENT DEVELOPMENTS IN PYELOGRAPHY.*

BY WILLIAM F. BRAASCH, M.D.,
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PYELOGRAPHY is not a new subject. The idea of injecting a substance which is impenetrable to the Röntgen ray into different parts of the urinary tract has for a long time been suggested by various observers.

To Professor Voelcker of Heidelberg must be given the credit of first demonstrating a radiogram of an injected renal pelvis in the living, and of calling attention to some of the possibilities of the method. For some reason the method did not arouse any general interest and nothing more was heard from it until within the last year or two.

So far as I have observed, the plates which had been published at the time I commenced my investigations almost two years ago showed no other condition than that of the normal pelvis and hydronephrosis. In a paper read before the United States Clinical Surgical Society last October and published in the ANNALS OF SURGERY for April, 1910, I was able to demonstrate plates showing a variety of conditions in the urinary tract, bringing out various associated data. Recognizing the practical value of the method, we have since employed it almost daily in St. Mary's Hospital. The illustrations for this article will be selected from several hundred collargol radiographs which we have made thus far.

*Technic.*—Following Professor Voelcker's suggestion, we have used collargol as the injected medium in most of our figures. The silver salt casts a definite shadow, and furthermore has the advantage that it can be used in weak solutions. A solution as low as 2 per cent. will often outline the renal pelvis quite clearly, and it can be injected without fear of harmful results. That it is a non-irritant is shown by its well-known use in intravenous injections. At operations we have repeatedly found collargol retained in the renal pelvis into which it had been injected several weeks before. It seldom causes more than a slight temporary irritation when injected. and does not interfere with primary union in operation wounds. Ordinarily we use a 10 or 15 per cent. solution, although a 5 per cent. solution suffices to cast a fair shadow. The stronger solutions generally cast a denser shadow, and retaining fluids in a dilated pelvis will often dilute even a 15 per cent. solution considerably. The amount injected will, of course, depend upon the size of the pelvis; a large hydronephrosis will contain several ounces without harm.

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* Read before the American Urological Society, June, 1910.

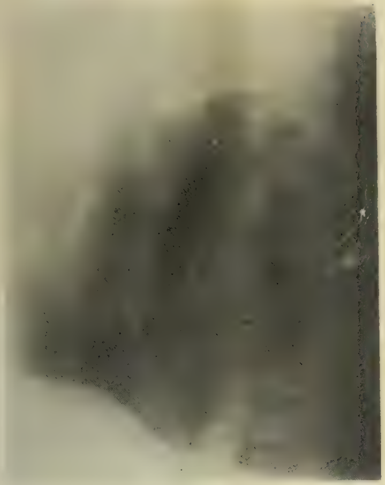
*The Normal Pelvis.*—As I have already stated, the normal pelvis will vary much in size and contour. In fact, in order to correctly interpret abnormality of the pelvic outline, one must become familiar with the wide range of pelvic contour. Marked colic, brought on by overdistention, will cause contracture of the normal pelvis and only a small slit will remain. As a rule a severe colic can be obviated by carefully injecting the fluid while the radiograph is being made. Without going more fully into the subject, I will show two extremes in the pelvic contour. Both were made in females with indefinite tumors in the right hypochondrium which, at operation, proved to be due to distended gall-bladder, while the kidneys were found normal.

Fig. 1 shows the slit-like pelvis in a normal kidney obtained immediately after injecting 3 c.c. of collargol, which caused a severe colic and which might easily be interpreted as the remnant of a pelvis encroached upon by surrounding tumor tissue.

Fig. 2 shows a large pelvis in a normal kidney with a content of 18 c.c. The pelvis, while of fair size, was not found abnormally large nor pathologic in any way. This is one of several figures which we have, showing a large normal pelvis containing from 15 to 25 c.c. collargol.

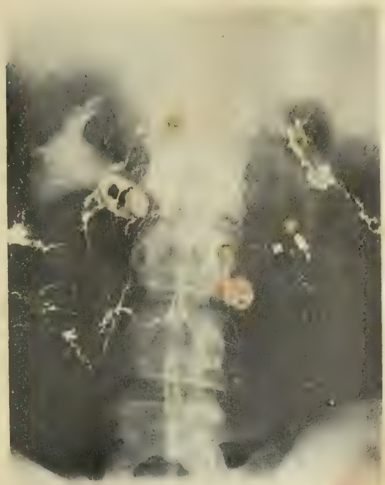
*The Dilated Pelvis.*—As before stated, the overdistention method, if correctly employed, is most accurate in determining

FIG. 1.



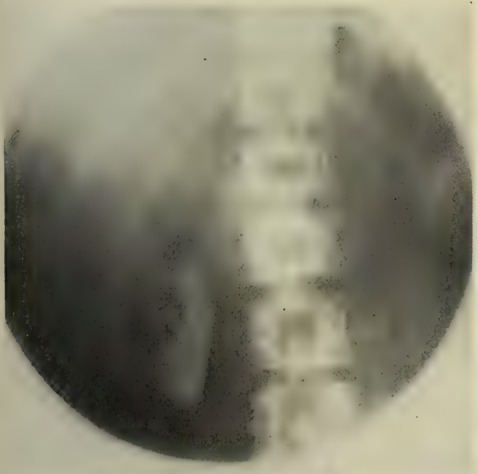
Normal pelvis in actual colic after injecting 3 c.c.

FIG. 2.



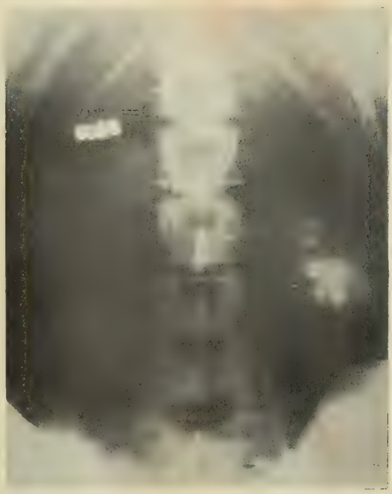
Normal pelvis with capacity of 18 c.c.

FIG. 3.



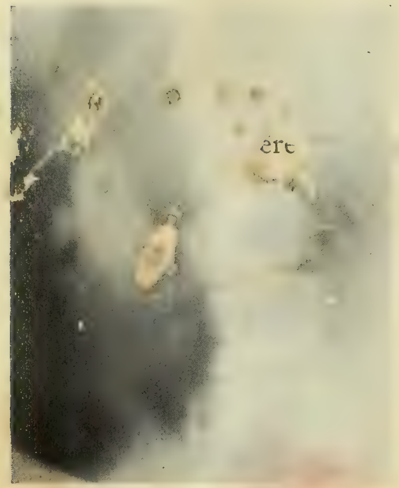
A moderate hydronephrosis partially distended because of impassable ureteral obstruction.

FIG. 4.



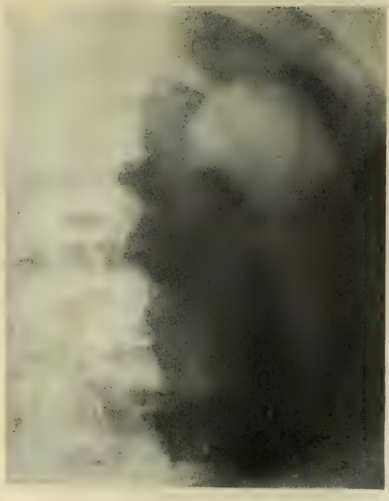
A moderate hydronephrosis largely within the renal substance.

FIG. 5.



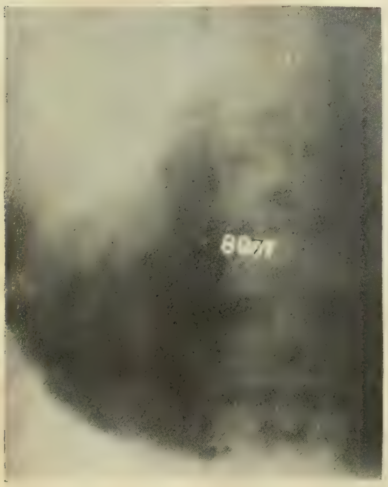
A retention or mechanical dilation of the renal pelvis.

FIG. 6.



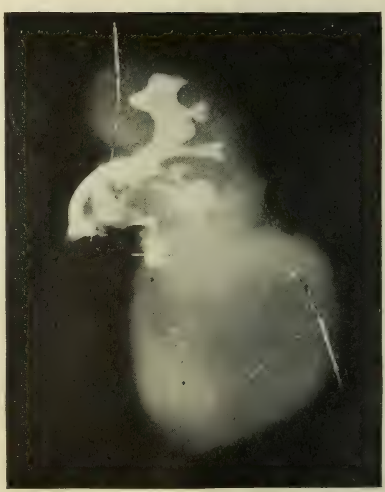
An inflammatory dilation of the renal pelvis.

FIG. 7.



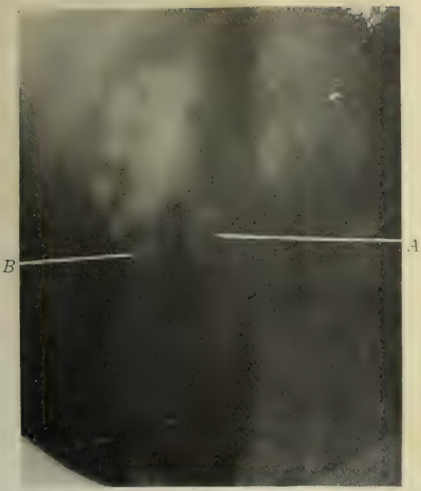
A combination of mechanical and inflammatory dilation.

FIG. 8.



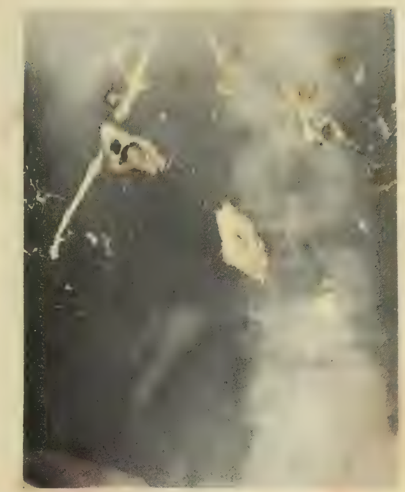
The pelvis invaded by tumor tissue, showing but little space remaining.

FIG. 9.



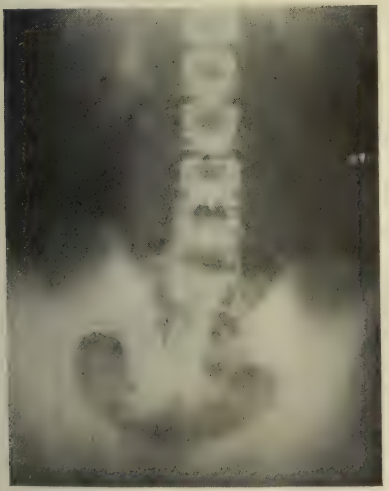
*A* and *B*, stones at the ureteropelvic juncture and in a lower calyx respectively. Also a retention hydronephrosis with but little functionating kidney.

FIG. 10.



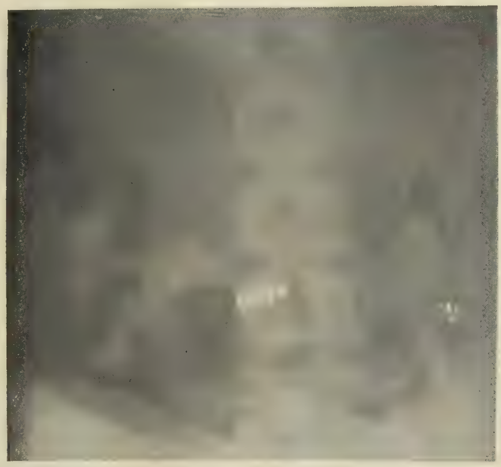
The upper shadow is that of a gall-stone; the lower that of a normal pelvis. The distance between identifies the former as extrarenal.

FIG. 11.



A hydro-ureter extending from the bladder to a hydronephrotic pelvis.

FIG. 12.



The irregular retracted pelvis occurring in a bilateral cystic kidney.

the existence and extent of a dilated pelvis, providing that the catheter is able to pass the etiological ureteral obstruction. However, it is always more satisfactory and of greater confirmatory value, at least, to visibly demonstrate the dilatation. Furthermore, when the catheter meets an impassable obstruction, enough collargol can frequently be injected past the constriction to outline the pelvis enlargement quite clearly. Fig. 3 illustrates a moderate pelvis outlined under such conditions. With the overdistention method the condition could not be demonstrated because of the immediate return flow of most of the injected fluid. On the other hand, there are undoubtedly hydronephroses which will not appear as such in the injected radiograph. This is particularly true when the dilation is largely confined within the contour of the kidney, where for some reason the free pelvic wall did not yield. This is graphically illustrated in Fig. 4.

The etiological factors, mechanical or inflammatory, are usually quite clearly defined in the pelvic outline. The mechanical or retention dilation is marked by regularity,—the even lines of the pelvic wall and the rounded ends of the dilated calyces (Fig. 5). The inflammatory pelvis, on the other hand, is irregular in outline (Fig. 6) and often with detached shadows caused by cortical abscesses connected with the pelvis. Occasionally we will get a combination of both factors. In Fig. 7 we have illustrated a retention pelvis as the result of some peripelvic inflammatory process. The regular dilation of the calyces is varied by the rather irregular outline of the free pelvic wall.

*Tumor Deformity.*—On account of the wide variation of size and shape of the normal renopelvic outline, we must be careful in interpreting a pelvic outline as pathologic. As previously stated, deformity of the renal pelvis caused by tumor will result from retraction of its whole or part of the tumor tissue, or from encroachment of the tumor in the pelvic space. Wilson[1] has demonstrated that in most renal neoplasms a marked deformity of the renal pelvis is visible in a cross-section. In a previous paper I published two collargol plates showing this deformity prior to operation. Naturally the pelvic outline must vary widely from the normal in order to be recognized as a deformity. In case of tumor retraction the pelvis may be irregularly large, or a single calyx may be distended and retracted over three or four inches. Again the pelvis at the uretero-pelvic juncture may be abnormally broad or square in outline. In case of tumor encroachment, but very little of the pelvic space must remain in order to be able to recognize actual deformity (possibly one or two thin streaks), or if the pelvic space is obliterated by the tumor, nothing would be visible except the collargol within the adjacent catheter. In Fig. 8 but two narrow shadows, one on either side of the encroaching tumor, show all that is left of the pelvis. Thin streaks spreading out into the kidney tissue may be all that is left of the retracted calyces. An interesting feature in such cases is, that injected collargol does not readily drain away, as can be demonstrated by radiography several days later, when shadows of the retained collargol will often be shown. Another point of corroborative value in suspected tumor of the kidney is to find the pelvis shoved over in unusual positions. In one of our figures it was found lying over the vertebral column. However, it will not be possible to make a radiographic demonstration of distinct pelvic deformity in every renal neoplasm. A large number, possibly a third of them, will not have enough deformity to be of diagnostic value. Again, because of obstruction to the ureteral catheter from various abnormalities in the course of the ureter, external pressure, or even ureteric metastasis, it will often be found impossible to reach the pelvis with the injected fluid. It has been our experience that in order to secure the best results, one should employ a fairly stiff catheter of as large a calibre as possible and radiograph while injecting the collargol.

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[1] Wilson: Old Dominion Journal of Medicine and Surgery, No. 4, April, 1910.

*Localization of Renal Shadows.*—While it is true that with good radiographic technic and apparatus, the kidney shadow can very often be fairly well outlined, nevertheless, for technical reasons in the course of routine examination, it will frequently happen that the renal outline is quite indefinite or will not show at all. Furthermore, distended gall-bladders, large abnormal livers, abdominal tumors, a large fatty capsule, etc., often obscure the kidney shadow and give misleading ideas of the exact outline and position. While it is very often possible to approximately localize renal stones in the kidney shadow if well defined, we have found that it can be done more accurately with the aid of collargol. A small stone deep in the calyx may, in the unaided radiograph, appear to be in the cortex, while in the collargol plate the cortical stone should usually be seen quite distinct from the pelvic shadow and its relative position in the parenchyma quite accurately ascertained. Pelvic stones will either be obscured entirely by the collargol shadow or show faintly through it. It is true that cortical stones just beyond a calyx may, in exceptional cases, appear to be continuous with the calyx shadow and in it. Furthermore, dilated ends of calyces may appear detached and may simulate cortical stones. Again, a stone in the lateral renal cortex in direct line with the pelvis might appear to be within the pelvis shadow, depending upon the comparative density of the stone and pelvic shadow. Such a lateral position is, however, rather infrequent. If any doubt exists, its position can be ascertained by making the radiograph at various angles. Another possible source of confusion may arise when extrarenal shadows are in direct line with the pelvis and may appear included within it. Nevertheless the stone can be definitely localized by means of the injected radiograph in most cases, which is of much aid to the operator (Fig. 9).

*Differentiation of Extrarenal Shadows.*—Although the extrarenal shadows can usually be identified as such, it is sometimes difficult to do so. The relation of the injected renal pelvis to a neighboring shadow is often an aid to its identification. This is particularly true in the differentiation of gall-stone shadows. With the development of radiographic technic, gall-stone shadows are being found more frequently. Peculiarities in the shadow will often assist in identifying them. When in a normal position, the distance between the gall-stone shadow and the injected renal pelvis should usually identify them as being extrarenal (Fig. 10). However, when the gall-bladder lies low and overlaps the kidney area, gall-stone shadows appear to be intrarenal, but peculiarities in their relation to the injected pelvis, together with cystoscopic data, should suffice to identify them in most instances. We have been endeavoring recently to employ stereoscopic collargol radiographs in their differentiation.

*Ureteral Obstruction.*—Obstruction to the ureteral catheter may be physiological and difficult to differentiate clinically from the pathological. An actual obstruction which occludes enough of the ureteral lumen to hinder the passage of the catheter usually causes enough urinary retention to produce more or less dilation of the renal pelvis and ureter above. This can be demonstrated frequently in a collargol radiograph. The method is particularly available in the diagnosis of ureteral stone, which, even with the best technic, will occasionally be missed by the radiograph. At times the obstruction is such that not even enough of the injected medium can pass to cast a shadow. More often, however, enough can be forced by to outline the dilated ureter and pelvis above, even though the catheter itself is blocked. Should the catheter pass the obstruction, in order to demonstrate the ureteral dilation, it is advisable to withdraw the catheter almost to the obstruction and then inject. We have several plates where ureteral dilation involves but a part of the ureter above the obstruction. Again, another plate shows but little dilation of the ureter above the obstruction, but considerable dilation of the pelvis. A peculiarity of low-lying ureteral obstruction, and particularly with long-standing or congenital obstruction, is frequently noted in that the first part of the ureter, extending from the ureteropelvic juncture to the first point of narrowing, will often remain undilated even though the remainder of the ureter is much distended (Fig. 11). Because of the difficulty of fully distending a dilated ureter, it may be impossible to outline the full extent of the dilatation. With extreme ureteral dilatation one should first endeavor to partially drain the ureteral contents and then inject a heavy solution of collargol. Profuse return flow alongside the catheter in a naturally flaccid ureter may give the appearance of a moderate dilatation.

*Solitary Kidney.*—The pelvic outline in solitary kidney may be of diagnostic value. In a plate already published, I demonstrated the pelvis of a congenital solitary kidney. The pelvis was shown to be about twice the usual size but with normal appearing calyces. On exploration the actual size of the pelvis was found to be commensurate with the hypertrophied renal parenchyma. An acquired solitary kidney, on the other hand, when the other kidney becomes functionless, will show a pelvis normal in size and contour. The parenchyma may be double its normal size, but the pelvis remains as it was before. It may be noted with interest that neither of the two cases showed any untoward symptoms following the pelvic distention.

*Renal Tuberculosis.*—It often happens that a non-tuberculous pyelitis occurs with clinical symptoms, *i.e.,* bladder ulcerations and unilateral cloudy urine, all suggestive of renal tuberculosis. Again, it may happen that a renal tuberculosis infects the bladder mucosa but little, and the clinical and cystoscopic picture may resemble a local pyelitis. It is peculiarly true that a pyelitis will often show a moderate pelvic dilation in the collargol plate. On the other hand, with renal tuberculosis a cortical abscess or an irregular pelvis and an inflammatory pyonephrosis may often be outlined and of distinct value in differential diagnosis.

*Cystic Kidney.*—In Fig. 12 we were able to demonstrate the pelvis of a cystic kidney. A clinical diagnosis of unilateral renal tumor was evident. The pelvic outline is similar to that usually found in inflammatory pyonephrosis. The catheterized urine being clear, pyonephrosis was excluded. Diagnosis of a malignant renal tumor could hardly be made from the figure because, (1) a pelvis of such proportions would be the result of a secondary degeneration and that such is not the case is proven by the clear urine; (2) the outline of a pelvis accompanying secondary degeneration in the malignant renal tumor would be quite different. The irregularly enlarged pelvis was found at operation to be due to retraction of a cortex resulting from diffuse cystic changes.

*Congenital Malformations.*—The frequency with which fused kidneys and median lying kidneys are found at operation should keep us on the lookout for them clinically. The position of a styletted catheter, as suggested by Kollischer and Schmidt, would usually suffice to determine anomalous positions in a radiograph. However, the size and shape of the pelves as well as that of the ureters can be outlined in addition to locating them by the injected radiogram. We found a very interesting condition in a plate recently; a moderately hydronephrotic pelvis was seen lying across and to the right of the second lumbar vertebra, with a dilated tortuous ureter leading to the left base of the bladder. The right renal pelvis and ureter were found to be normal in position and size. The plate, which was made stereoscopic, made the lower pelvis appear at a level much more anterior to the right and uppermost pelvis. An interpretation of the plate was rather difficult. We knew that we were dealing with a small hydronephrosis and obstructed ureter, but whether this occurred in a congenital pelvic kidney or in a fused kidney, we could not determine. Judging from the distance between the two pelves and the fact that the lower pelvis lay so far anterior to the upper one, we inferred the existence of two separate kidneys as the more probable. At operation a fused kidney seven or eight inches in length was found. It had three distinct pelves. The two upper were normal and connected with the ureters which fused above the bladder. The lowest pelvis was found to be hydronephrotic, as demonstrated in the plate, and with a dilated tortuous ureter.

*Stereoscopic Radiographs.*—We have recently made stereoscopic collargol radiographs which promise to give in-

teresting data. They should be of
the demonstration of shadows at diffe
injected pelvis. This should be part
differential diagnosis of overlying gall-
fortunately, the shadows cast by the or
kidney are usually too dim to be of m
in the stereoscope.

We have therefore proven qui
radiograph and cystoscope, working
possible to demonstrate many condition
fail to demonstrate alone. We have
injected radiograph to be of consideral
demonstrating the following conditions
(2) hydronephrosis; (3) pyonephrosis
renal tuberculosis; (6) renal tumors;
differentiation; (8) horseshoe and medi
solitary kidney (unsymmetrical); (10)
differentiation of extrarenal shadows;
renal shadows; (13) aid to ascertain renal functional capacity; (14) identification of ureteral obstruction; (15) hydro-ureter.

# TE ON THE REMOVAL OF CARCINOMA OF THE FUNDUS OF THE URINARY BLADDER.

BY FRANCIS R. HAGNER, M.D.,

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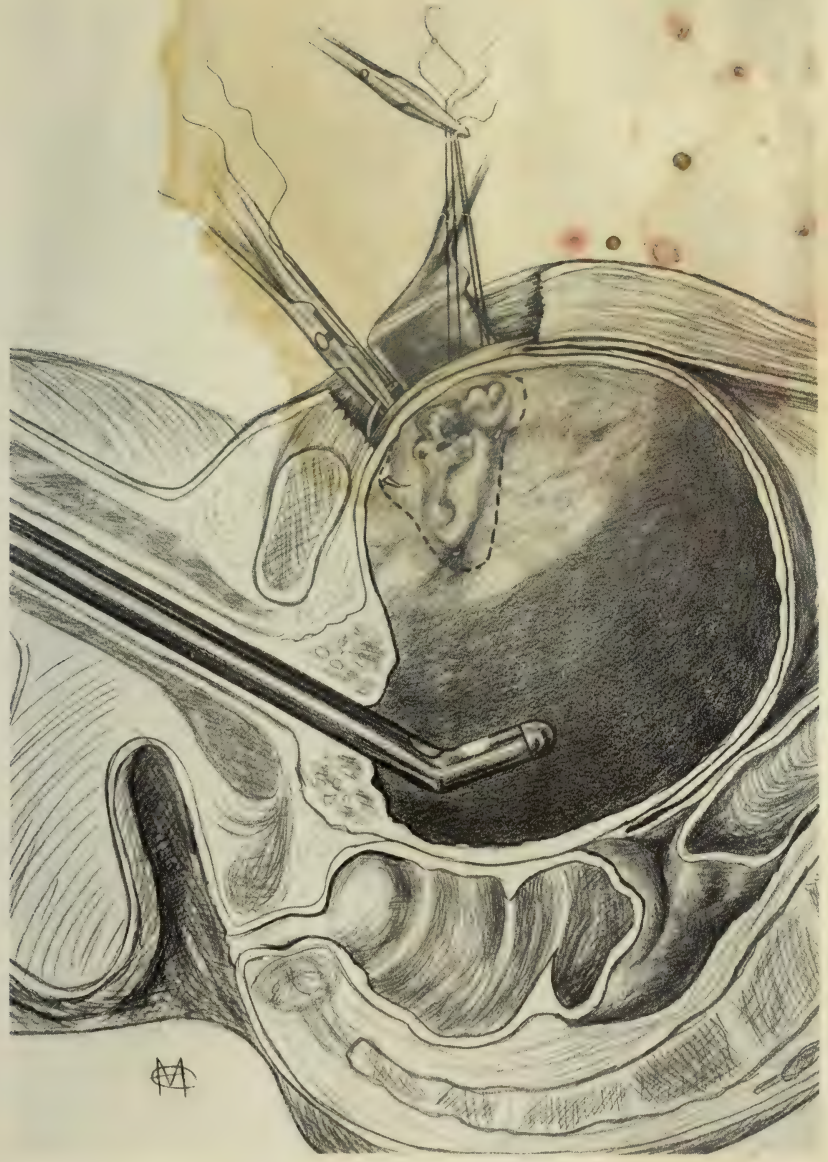
fessor of Genito-Urinary Surgery in the George Washington University.

T[illegible]undus of the bladder is a comparatively rare location for new growths, the more common seat being the base.

It has been my fortune to have two cases of carcinoma of the fundus of the bladder under my care during the last few months, both operable. My inability to remove the friable tumor in the first case without breaking the tumor mass suggested to me the method of removal that was resorted to in the second case. By the *old* method of procedure (which was followed in the first case) just as soon as the incision was carried through the bladder wall this viscus collapsed, thereby making it impossible to determine the location for my incision on the other side of the tumor without introducing fingers into the bladder. The manipulation of the tissues by the fingers, necessary to determine lines of incision, caused a crumbling and breaking off of many small portions of the neoplasm. I believe it is generally conceded that one of the weakest features of the operative treatment of newgrowths of the bladder is the production of trauma to the tumor mass during its removal. It is possible, with proper care exercised, to remove tumors from the fundus and lateral walls of the bladder without the slightest traumatism to the tumor mass by the method I will describe. The operation is impracticable for tumors of the bladder *base,* which, unfortunately, is the most common situation for the growths. The following is the report of the case and description of the operation.

Male, white, forty-three years of age, was referred to me by Dr. Shaw, on March 15, 1910. Eight months ago patient began passing dark soft solid masses of tissue in his



Showing use of sutures to outline bladder tumor.

urine. From two to three days before the passage of the masses the urine would become coffee colored, but after the passage it would clear and become normal. He has passed these pieces of tissue five times during the past eight months. He had no fr quency of urination or bladder pain. On his first visit he brou the last piece of tissue he had passed. This appeared to be g grenous epithelial tissue. The man was well nourished otherwise apparently healthy. His prostate and seminal vesicles were normal. Cystoscopic examination March 17, 1910, at Garfield Hospital, showed a bladder capacity of 350 c.c., a normal bladder mucosa except to the right of fundus, where a partially ulcerated growth, 5 c.c. in diameter, was noted, covered with black necrotic tissue. The mucous membrane was raised in several areas around the base, showing infiltration of the bladder wall by the new growth. A diagnosis of carcinoma of the anterior and right lateral wall of the bladder was made. Patient was operated on March 19.

The following is a description of the operation employed: The bladder was irrigated, and on account of bleeding, adrenalin 1 : 10,000 was instilled and allowed to remain five minutes. The bladder was then distended with 350 c.c. of salt solution, and a Nitze cystoscope was introduced. This was held in place by an assistant, while a suprapubic incision down to the bladder wall was made. The prevesical fat was well separated and the tissues well retracted by wide lateral retractors so as to give a good exposure of the bladder wall. The growth was then inspected through the cystoscope, the right hand holding the cystoscope; with the left, a needle was pressed on the fundus of the bladder, and the dimpling caused thereby was readily seen through the cystoscope. The needle was carried first to the left of the growth at a sufficient distance to give a margin of healthy bladder wall, it was then plunged into the bladder, being held in place by an assistant. The same procedure was carried out at the right of the growth and at the lower border. An attempt to place a needle above would have penetrated the parietal peritoneum, as this was involved in the growth. A sharp knife was now carried to the outer side of the three needles placed around the growth, the portion of the bladder wall to be removed being clamped at its cut edge as soon as the incision was started. The bladder wall containing the growth was lifted up by the clamp and held by an assistant. The fluid left in the bladder was removed by a large syringe through the suprapubic wound to prevent its entrance into the peritoneal cavity. The incision in the bladder wall was then carried upwards into the peritoneal cavity and a portion of parietal peritoneum covering the growth was removed. The bladder and peritoneal wounds were then closed by two rows of sutures, a suprapubic drain being left in the bladder.

As far as I am able to learn, this method of attacking these growths has not been tried before. As I have stated, the operation is only applicable to growths in the fundus and lateral walls, but even when the growth is near the base it may be possible to get one or two points to guide us in the incision so as to prevent the traumatism to the growth by handling. I believe it is better to use sutures to fix the points of incision in preference to the needles I employed, as there is a slight leakage of fluid around the needles that lets the bladder wall relax and makes the introduction of the last needle difficult. On the other hand, a threaded needle can be seen with the cystoscope when it enters the bladder, and the location of the suture when in place can be readily noted if slight tension on it be made, so as to cause a stretching outward of the bladder wall at the point of suture. This tension also prevents leakage of fluid and facilitates the introduction of the other suture by preventing the slight collapsing of the bladder wall.

The patient on whom this operation was performed has made a good recovery and is apparently in good health. Of course it is too early to express any opinion as to the ultimate result in this case, but we do know that the tumor was removed without the slightest traumatism to the growth—not even the necrotic tissue present was disturbed.

# INTRAPERITONEAL CYSTOTOMY.

BY CHAUNCEY E. TENNANT, M.D.,

OF DENVER, COL.

SURGICAL progress has always been subservient to tradition. This is as it should be, for only by careful consideration of past experience has it been possible to maintain surgical procedure on a safe and sound basis. It is this same tradition which is, no doubt, responsible for the present hesitancy in attacking the urinary bladder through the peritoneal cavity.

The possibilities and advantages of this route were successfully worked out and recommended by Harrington in 1893.[1] Since this admirable report, little or nothing appears in the surgical literature regarding this method of cystotomy, until an article by Charles H. Mayo in the July number of ANNALS OF SURGERY, 1908, entitled "Transperitoneal Removal of Tumors of the Bladder." Following this, two more contributions have been made to American literature regarding the method and technic, and report of cases. These are by Scudder and Davis, in the ANNALS OF SURGERY, vol xlviii, December, 1908, and E. S. Judd, in the *Journal A. M. A.*, vol. liii, December 25, 1909.

Long before Harrington pointed out the possibility of successful transperitoneal cystotomy, it was known that a normal urine was practically sterile.[2] It was also a well-known fact that punctures and accidental injuries to the ureters and bladder, occurring during operations, readily healed when properly repaired. In the face of all this, the persistent effort to avoid the intraperitoneal invasion of the bladder can only be attributed to a certain close adherence to time-honored traditions.

Why these should have retarded the development of urinary surgery more than other fields is difficult to explain, for the suprapubic and perineal muscle splitting operations, which have always been the recognized course of procedure, are attended with a high mortality, and sometimes the permanent discomfort of a urinary fistula.

While it has long been recognized that urinary infiltration into the muscle planes produced early and profound absorptive symptoms, and even fatal toxæmias, it has also been known that the peritoneal cavity better tolerated this same urine. But in spite of all this, there has been a persistent choice of the route through the muscle planes to the bladder, neglecting the rapid healing, tolerant, and effectual peritoneal route.

Harrington, in his first report, said: "Intraperitoneal cystotomy may be performed for tumors of the bladder, for enlarged prostate, for disease of the ureters, for cases of large stone in the bladder, and for sacculated stone; there are advantages in the operation which, certainly at times, render it preferable to suprapubic cystotomy."

Watson in a comprehensive report, "The Operative Treatment of Tumors of the Bladder,"[3] which covers records of 643 cases, says: "That 28.6 per cent. of benign and 46 per cent. of carcinomatous growths of the bladder have been surgical failures."

This is, of course, by the use of the muscle splitting suprapubic and perineal routes. In this same report Watson also shows that by the suprapubic route papillomata have been removed with 20 per cent. mortality, carcinoma with 28 per cent., and sarcoma 63 per cent., early recurrence following in both the benign and malignant forms in over 20 per cent. of the cases.

This high mortality is no doubt partially due to the urinary absorption through the severed muscle planes; also to the ineffectual means of reaching the tumor. The frequent recurrence is no doubt due to the incomplete removal of the mass and its adjacent tissue.

Dr. Charles Mayo in his report on "Transperitoneal Removal of Tumors of the Bladder" in the July ANNALS OF SURGERY, 1908, says:

"We have not been satisfied with the ordinary suprapubic incision in operating upon large tumors of the bladder."

According to Judd,[4] 90 per cent. of the tumors of the bladder begin in the base, consequently with the suprapubic and perineal incisions, it is impossible to secure good exposure or do a radical operation, and he further adds: "after closing the suprapubic incision in the bladder, we (the Mayos) have occasionally had the wound open and the urine drain for some time through this opening, *but in no instance has there been leakage from the incision through the peritoneal surface, which is no doubt owing to the firmer and more rapid healing of the peritoneum.*"

Statistical and clinical observation therefore indicate that intraperitoneal cystotomy should be more frequently the method of choice, and often it is the only method which can give any reasonable promise of permanent relief.

The more recent literature reports the successful use of the transperitoneal route for vesical tumors, especially where thorough inspection or removal of the bladder wall is deemed necessary. The mortality from this work appears to be decidedly less than with the muscle splitting operation, to say nothing of the security that comes with the knowledge of immediate bladder closure, and the comfort of the patient and nurses, while it also affords the best possible visual and operative access to all parts of the bladder.

Contrary to what one might naturally expect, the free opening of the bladder into the peritoneal cavity is not attended with a copious and annoying overflow of urine into the operative field. Somewhere in the recent literature I have seen the statement made that when an anæsthetized patient is placed in the Trendelenburg position (which is necessary in the transperitoneal cystotomy), there is practically little or no urine secreted, and this has seemed to be true in the cases I have operated by this method.

While I do not mean to advocate transperitoneal cystotomy in any but selected cases, I am sure that more successful results in bladder work may be accomplished, with considerably less mortality and much greater comfort to the patient, by the intraperitoneal route.

The method of operation as first recommended by Harrington, and later endorsed by Charles Mayo, Scudder, and Judd, is practically the same. The patient is placed in the Trendelenburg position, and a long median incision is made from the umbilicus to the symphysis pubis. The muscle planes, through which the incision has been made, and the abdominal viscera are packed out of the way, and the superior external angles of the bladder picked up and brought forward. An incision is made in the superior and posterior surface, the urine mopped out, and the incision continued down the posterior surface as far as deemed necessary. Two anchoring sutures may then be introduced through the bladder wall to spread the borders of the incision, when a full view of the inside of the bladder is obtained. Tumors may then be outlined, their relation and extent determined, and radical operations done for their removal.

Large sections of the bladder wall may be excised and the ureters transplanted with apparently no greater mortality than occurs in the ordinary ineffectual suprapubic operations.

Most authors recommend chromicized catgut through-and-through Connell suture, in closing the bladder, this to be followed by a peritoneal reinforcement with a linen Cushing suture.

I have used this method, and also plain catgut throughout, and now prefer the latter because of its certain and early absorption. Chromicized catgut may be more certain of holding the parts together, although I have found the knot (which should be made inside the bladder) discharge through the urethra five days after the operation.

A catheter may then be introduced into the bladder for continuous drainage, although some claim this is not necessary. I have been disposed to use the catheter for the first week following an intraperitoneal cystotomy. One certainly feels more secure with this safety-valve in place, and it offers but little added inconvenience to the patient, with no increased danger.

There is no need of testing the bladder for leakage, for if the through-and-through sutures are well placed, close together, and the peritoneal covering well overlapped, it is certain to be water-tight under normal pressure.

The parietal peritoneum is then closed as usual, and the muscle sheaths united as in any other abdominal operation, excepting, however, in the writer's experience, the introduction of a small drainage tube down to the peritoneum for the first forty-eight hours. This procedure will save a possible postoperative abscess in the muscle planes, which is prone to occur where bacteriuria is present. If one has been careful to protect the edges of the abdominal incision, and feels absolutely certain there has been no infection, this last step may not be necessary, although it is advisable, as it affords escape for any urine left in the incision after the operation.

In two recent cases which I shall briefly report, I learned that it was possible to perform an intraperitoneal cystotomy in the presence of a very marked cystitis, although I do not wish to be understood as recommending this procedure without some very good reason for so doing. Both of these cases had a cloudy alkaline urine with pus, colon bacillus, and other pyogenic micro-organisms, but after careful consideration, it seemed best to use the transperitoneal route. Both cases were operated, the bladder immediately closed, and successful results secured, sparing both the patients and myself the annoyance and apprehension of a urinary fistula.

Case I.—Mr. P., age fifty-five, had hæmaturia for the past year, first at irregular intervals, then free and constant, with urinary obstruction due to large blood-clots. Patient lost considerably in weight; also much sleep, owing to frequent nocturnal micturition. Digital examination of the bladder through the rectum disclosed a horned-shape mass extending upwards and into the bladder from the upper border of the prostate gland. This tumor, although hard, seemed to involve the muscular coat. It was very difficult to use the cystoscope, owing to the great amount of bleeding, which frequent washing would not eliminate. However, a fair view was obtained of the upper surface of the mass, a deep ulcer appearing at the very apex.

The urine contained pus and blood, with a specific gravity of 1020, acid reaction, and a marked bacteriuria—colon bacillus and staphylococcus.

Removal by the transperitoneal method, following the technic as above described, was effected. A thorough removal of a hard indurated mass was accomplished, together with the prostate and a considerable portion of the mucous membrane. The bladder and abdominal incisions were completely closed, a catheter inserted in the urethra, and the bladder washed out once daily for the first week. There was no rise in temperature, no infection, and perfect repair, patient being discharged in two weeks.

Case II.—Mr. W, age twenty-one. After fall on perineum one year ago, developed frequent urination with dysuria. More recently has had frequent chills and temperature, loss of weight and sleep, and is compelled to wear a rubber urinal both night and day. Examination with the finger in the rectum discloses a large mass about the right prostatic lobe, which is extremely tender. The urine is strongly alkaline, cloudy, foul odor, full of pus, and loaded with colon bacilli and diplococci. Sounds failed to disclose anything suggesting stone. While the use of the cystoscope provoked much tenesmus, in spite of the local anæsthetic which had been used, a little perseverance brought the lower end of the bladder into full view, when all question as to the diagnosis was put at rest by the sight of a large irregular white mass, covered with slimy mucus, and apparently partially encysted in the bladder wall. About this mass, as far as could be seen, the bladder was thick, œdematous, and suggestive of some other hidden lesion. Operation being at once accepted, I decided to undertake the transperitoneal method because of the appearance of the bladder wall and the embedded stone.

After making the abdominal incision, I discovered a chronic catarrhal appendix and removed it. Then packing everything well away from the bladder site, I made a long incision on its superior and posterior surface, delivered the stone weighing 26.5 grammes, examined the bladder walls and the urethral outlet, closed the bladder, introduced a soft rubber urethral catheter and washed out the bladder once daily.

A rise of temperature on the third day gave warning of a subcutaneous stitch abscess, which necessitated the removal of several of the retaining sutures and drainage down to the peritoneum. The infection readily yielded to this treatment, and the abdominal incision promptly closed. The catheter was removed the seventh day, and the patient was out of bed with good bladder function on the fourteenth day.

While these are the only two cases which I have operated by this method, neither of them suffered with troublesome urinary fistulas nor had a complication because of opening a septic bladder. I report them, not to encourage the intraperitoneal cystotomy in every bladder lesion, but to show that it is possible to use this method even in the face of marked bacteriuria.

## BIBLIOGRAPHY.

[1] Harrington: Annals of Surgery, October, 1893.
[2] Howitz: *Ibid.*, xlii, 857.
[3] Watson: Annals of Surgery, xlii, 807.
[4] E. S. Judd: Journal A. M. A., liii, 2147.

# A CHART TO AID IN THE TREATMENT OF CYSTITIS BY DISTENTIONS OF THE BLADDER.

BY HOWARD A. KELLY, M.D.,

OF BALTIMORE, MD.

I do not think we yet fully appreciate the value of appealing whenever it is possible to the eye as well as to the ear in our medical work and teaching. In instructing students and in demonstrating methods of operating in our text-books, the appeal to the eye by illustrations is now used with a fair degree of liberality, but there are other fields than these almost untried.

I have recently devised and am now using a chart such as shown in Fig. 1, as a valuable adjuvant in the treatment of cases of cystitis, and it is because I believe that some such ocular demonstration of the progress from week to week ought to be used in every case, that I here offer this simple but serviceable suggestion in the hope of extending its field of usefulness.

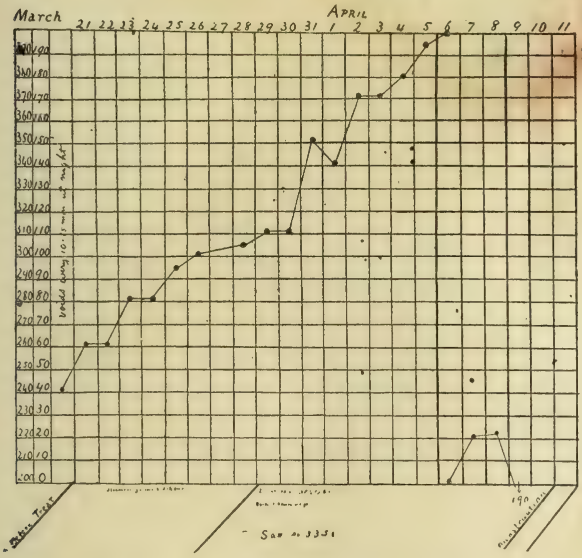
My patient was a married woman, thirty-seven years old. She had had no pregnancies in eight years of her married life. Her general health was good, and the entire complaint was lodged in the bladder, which began about six years ago to trouble her with sticking, knife-like pains in the lower abdomen, which became worse on exertion. Three or four years ago she had a frank attack of cystitis, when she passed a great deal of blood. The added pains associated with this attack have been pretty constant since that time, although there have been occasional remissions. She has often been compelled to void her urine 15 or 20 times a day as well as incessantly at night. She was so worn-out and nervous from her sufferings that she could not even endure an ordinary gently executed cystoscopic examination, so I gave her an anæsthetic and then examined the bladder at leisure and very thoroughly through my aero-cystoscope.

At the examination I found an injected area of pronounced cystitis with disappearance of the vesical vessels occupying the left lateral wall of the bladder and a part of the vertex. The rest of the bladder was normal and there was no disease at the base or abnormality about the ureteral orifices.

Treatment was then begun with an intelligent idea as to just what the disease was, where it was located, and how extensive it was. This was valuable also as a basis for comparison in following up the results of treatment.

I followed four courses in treating her: 1. Rest, not absolute but relative. She was required to take things very easy and to lie about especially after the treatments. 2. Medication, there was but little medicine given by the mouth. 3. Local therapy, which constituted the sheet anchor in the treatment and to which she owes her improvement almost exclusively.

FIG. 1.



This consisted in distending the bladder to a maximum at first with a warm boric acid solution, followed at the end of the irrigation and distention by the instillation of a solution of nitrate of silver (1 : 1500).

At the suggestion of Dr. C. F. Burnam, my associate, I later used a carbolic acid solution (½ pc.) for the distentions, on account of the sedative action of the drug as well as its value in sterilizing the surfaces with which it came into contact.

After the treatment was well under way, I conceived the idea that it would be a great help to the patient as well as to me if a large graduated chart like a temperature chart were made and hung on the wall, for the purpose of showing at a glance just what progress had been made from the first, what the actual status was at any given time, and what was expected for the future, that is to say, how great was the distance still remaining to the goal.

Such a chart serves both doctors and nurses as an excellent basis of appeal to the patient to do her best, and is a moral stimulus in moments of depression. She will not then be so likely to worry over little diurnal variations with the written record of decided improvement before her.

One can also determine the effect of psychic or of physical causes on the toleration of the bladder as well as the beneficial effect of any particular drug being used. In this special case my goal is a content of 500 c.c. (one pint). Starting out with an intolerant bladder tolerating only 40 c.c. (a little over an ounce), we have gone steadily up to over ten times the amount in seven weeks; no bad record for a case of years' standing. With this measured and charted improvement has gone a like improvement in all the symptoms. She used to void from 10 to 15 times at night, now it is but once or not at all.

On reaching the top of the chart one may begin again at the bottom using the left-hand column of figures with 200 on the lowest line and ascending to 400. When she runs again to the top I will write 400 to the left of the 200 column and carry the enumeration up to 500 or 600, where we will stop.

To effect this improvement I have given her 36 irrigations and 140 distentions. That is to say the bladder is irrigated every day if there is no reason to the contrary, and at each irrigation it is distended several times to a maximum.

In addition to the encouragement such a chart gives patient, nurse, and doctor, it is a great time saver and saves reading over the daily records to see what has been effected.

The individual squares in the figure are 1.5 cm. each way. I would make the chart long enough to hold from 30 to 50 treatments, and count each square equal to 10 c.c. of distention. Checker paper or chart paper can be bought for a few cents a sheet in larger or smaller squares suitable to hang on the wall or to file away with the history. A fine paper is Webb's co-ordinate draughting paper, which comes retail at 5 and 10 cents a sheet, less in quantity.

# IS THE SAC OF A FEMORAL HERNIA OF CONGENITAL ORIGIN, OR ACQUIRED?

BY R. W. MURRAY, F.R.C.S.,

OF LIVERPOOL, ENG.

THERE is an ever-increasing tendency to regard the sac of an ordinary inguinal hernia as being of congenital origin and not acquired. The evidence that can be advanced in support of this view is very complete and convincing. In this communication I wish to direct attention to the etiology of femoral hernia, and will endeavor to answer satisfactorily the question, "Is the sac of a femoral hernia of congenital origin, or acquired?"

Though the sac of a femoral hernia is almost invariably found to occupy a position between the femoral vein and Gimbernat's ligament, cases have been recorded in which it has been seen in other situations. It has been found to descend in front of the femoral vessels, external to them, behind them, and even to pass through the fibres of Gimbernat's ligament.

Partridge, in the *Transactions of the Pathological Society* for 1847, relates a case of double femoral hernia in which both sacs were outside the femoral vessels. The left sac contained the sigmoid flexure; the cæcum and vermiform appendix were in the right. The accompanying drawing (Fig. 1), which is copied from Macready's "Treatise on Ruptures," shows three sacs—one in the usual position of a femoral hernia, a second peritoneal sac had traversed Gimbernat's ligament, and a third protruded over and to the outer side of the femoral artery.

These three peritoneal diverticula appear to me to have a very important bearing upon the etiology of femoral hernia. Macready tells us that: "The specimen was taken from the body of a woman between forty and fifty years of age, who had a rupture for several years. The hernia is in the usual situation. The abdominal entrance of both the other pouches was narrower than the fundus, and both were surrounded by fat which had been partly removed by dissection."

How are we to explain the formation of these three peritoneal diverticula?

Surely one of two explanations must be true—either all three sacs had been acquired, or, as appears more probable, all three were of congenital origin. The fact that three diverticula were found in such close proximity is in favor of the developmental view; and this view as to their origin receives support from their shape, for it is distinctly stated that the abdominal entrance of both of these pouches was narrower than the fundus. Had these diverticula been produced by the bowel pushing the peritoneum in front of it, then the mouth of each sac would have been wide.

It might be argued that all three diverticula were acquired; that is to say that all three at one time were hernia sacs, but in two of them the neck and mouth of the sac had become narrowed, having undergone a natural cure. The objection to such an explanation is that clinical experience has never yet furnished a single instance in which an undoubtedly acquired hernia sac has undergone a spontaneous cure. The evidence, then, is strongly in favor of the congenital origin of two of these sacs, and as it is extremely unlikely that an acquired hernia sac would be formed between two existing peritoneal diverticula, we are compelled to believe that, in this instance at all events, the femoral sac was also pre-formed.

Though it is true that femoral hernia is seldom met with before adult life, still a number of cases has been recorded in which the hernia first appeared during childhood, and others in which it was present at birth or noticed during infancy.

In the ANNALS OF SURGERY for October, 1906, Wm. B. Coley, writing on the radical cure of femoral hernia, says: "Between the years 1891 and 1906 I performed 117 operations for femoral hernia in 105 patients. In 34 of these operations the patients were children between the ages of two and fourteen years. Nine were males and 18 females. In three operations the patients were under five years of age; in 15 operations the patients were from five to ten years of age; in 14 operations the patients were from ten to fourteen years of age."

In the article on hernia in Keating's "Cyclopædia of the Diseases of ldren," two cases of femoral hernia recorded by Edward Swasey are rred to. "A boy sixteen years of age presented himself at the hospital unmistakable double femoral hernia. His mother said that when one old he had a bad bronchial affection, with severe cough, and during time the tumors appeared. They would disappear on lying down and ase in size on standing up, and especially upon coughing. The boy he lumps had been present as long as he could remember."

wa lso mentions another case of femoral hernia in a girl twelve of age, whose mother positively asserted that the swelling had been nt for four years.

homas Bryant, in the *Medical Times and Gazette* of 1862, vol. i, reports two cases of femoral hernia which occurred in girls, aged nine and twelve years respectively.

Edmund Owen, in his work on "Surgical Diseases of Children," mentions the case of a female child, six years of age, upon whom he operated for strangulated femoral hernia.

Ashby and Wright, in their work on "Diseases of Children," mention that Sabourin recorded a case of femoral hernia in a premature infant.

John Birkett, writing on hernia in Holmes's "System of Surgery," mentions a case of crural hernia he saw in a girl ten years old.

Lockwood, in his work, "Hernia, Hydrocele, and Varicocele," mentions two cases of femoral hernia upon which he operated, and which he considers might possibly have been congenital. "They occurred in boys aged twelve to fifteen, and had existed for years."

Macready, in referring to persons seen at the City of London Truss Society during the years 1888, 1889, and 1900, mentions 22 cases in which femoral hernia was met with in males under fifteen years of age, and 42 cases in which femoral hernia was noticed in females under fifteen years of age.

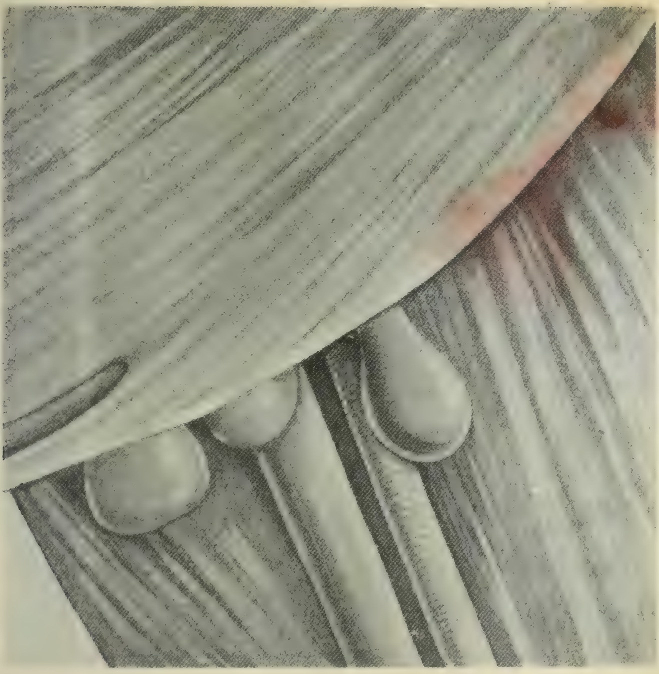
We have, then, 104 cases of femoral hernia occurring in children under fifteen years of age. In 52 of these cases the hernia first appeared between one and ten years of age, and in 9 instances it was first noticed before the children were five years old.

The relative frequency of femoral hernia in male and female children is about 1 to 2.

CASES OF FEMORAL HERNIA IN CHILDREN, ACCORDING TO AGE WHEN THE HERNIA WAS FIRST NOTICED.

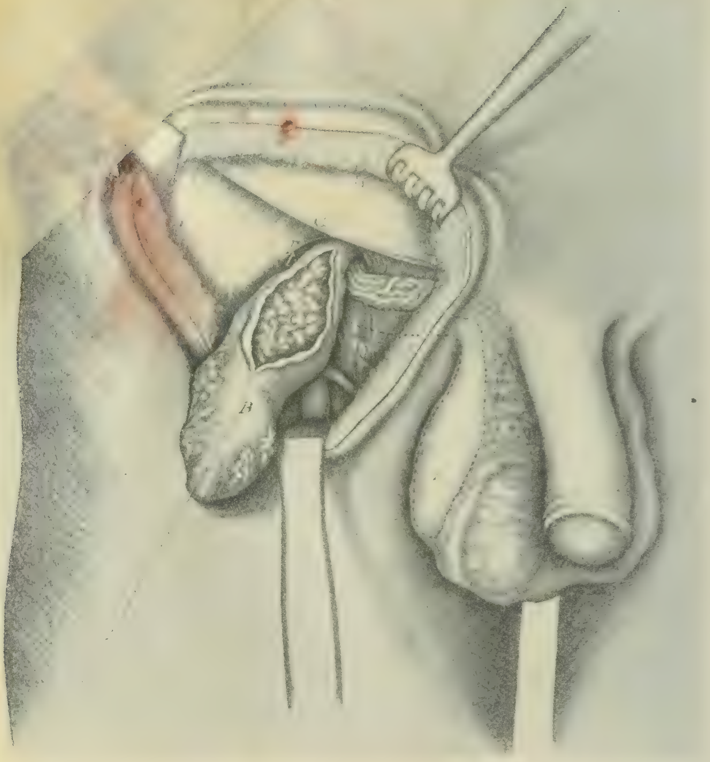
| | |
|---|---|
| 1– 5 | 9 |
| 6–10 | 43 |
| 11–15 | 52 |
| Total | 104 |

FIG. 1.

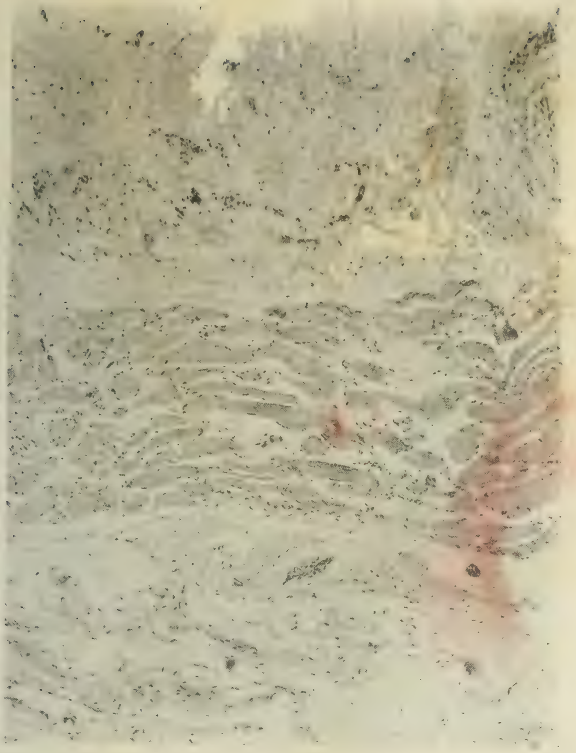


Three crural peritoneal diverticula. The central protrusion is the sac of a femoral hernia in the usual situation. A second sac had traversed Gimbernat's ligament, and a third had protruded over and to the outer side of the femoral artery.

G. 2.

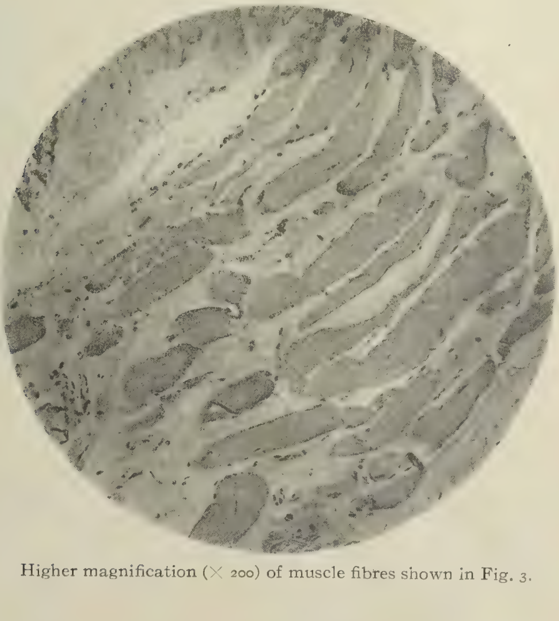


Cruroscrotal hernia. *A*, femoral ring; *B*, sac; *C*, omentum; *D*. cord; *E*. bed of the sac; *F*, falciform ligament; *G*, Poupart's ligament; *H*, aponeurosis external oblique muscle; *I*, Gimbernat's ligament; *J*, pectineus muscle.

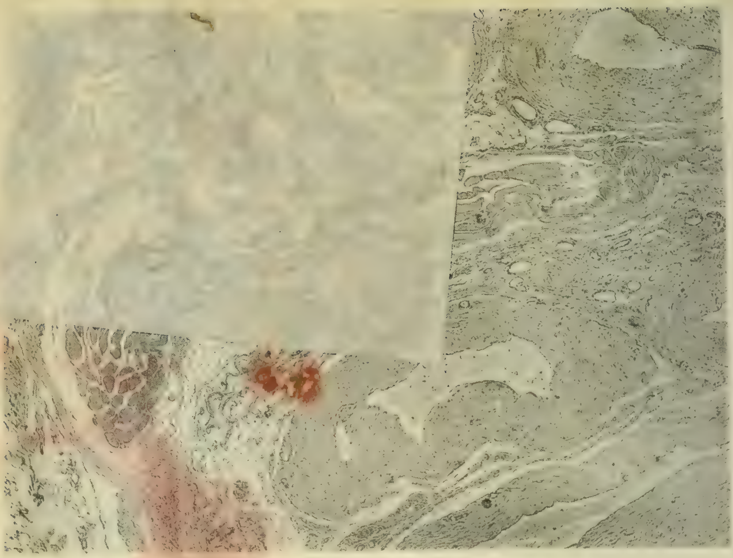


Muscular fibres from the fundus of a femoral hernia sac. (× 60 diam.)

Fig. 4.

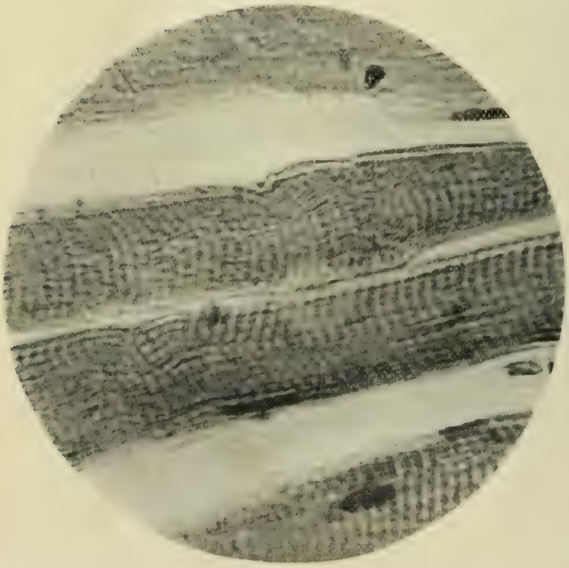


Higher magnification (× 200) of muscle fibres shown in Fig. 3.



Normal gubernacular fibres (× 38 diam.).

FIG. 6.



Higher magnification (× 1000 diam.) of muscle fibres shown in Fig. 5.

In accordance with orthodox teaching, all these 104 hernia sacs had been acquired; but considering the ages of the patients, and remembering that in 9 instances the hernia first appeared between one and five years of age, it is surely far more probable that the bowel had descended into a pre-formed sac.

In the case recorded by Edmund Owen, where strangulation of a femoral hernia occurred in a child six years of age, the only possible explanation is that the bowel had suddenly entered a pre-formed sac.

Femoral hernia is so frequently met with that if its essential cause is the presence of a pre-formed sac, then we would expect to find small peritoneal diverticula occupying the crural region, altogether apart from hernia.

In 200 consecutive post-mortem examinations, kindly made for me by Dr. Nathan Raw at the Mill Road Infirmary, upon persons in whom during life there was no history or evidence of hernia, in 47 bodies 52 femoral diverticula were present. In 14 instances they were bilateral. They invariably occupied a position corresponding exactly to that of a femoral hernia, and in shape closely resembled the inguinal pouches, having a narrow mouth and lumen, which would make it appear more probable that they were produced by some force pulling the peritoneum outwards, rather than by a pushing force from within. The fact that in the 47 bodies more than one diverticulum was present in 16 instances strongly suggests a developmental origin for both the inguinal and femoral pouches, and this view is strengthened by one case (No. 9) in which a double inguinal and double femoral sac existed.

I would call attention to the fact that so many of the femoral sacs were bilateral, and that in another case (No. 45), a girl aged seven years, a femoral diverticulum was present on both sides of the body. These femoral pouches are either all of congenital origin or all have been acquired; no compromise can be accepted. If they are all of congenital origin, and occur with such frequency as the tables indicate, and are so often found in the position which the sac of a femoral hernia normally occupies, then why suppose the sac of a femoral hernia is ever acquired?

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|  |  |  | ight femoral. |
| 5 | " | 39 | [illegible] ined omentum). |
| 6 | " | 55 | Left inguinal (contained omentum). |
| 7 | " | 42 | Left femoral. |
| 8 | " | 29 | Right femoral. |
| 9 | " | 44 | Double inguinal and double femoral. |
| 10 | " | 30 | Right and left femoral. |
| 11 | " | 63 | Right and left femoral. |
| 12 | " | 62 | Right femoral. |
| 13 | " | 32 | Left inguinal. |
| 14 | " | 45 | Right femoral. |
| 15 | " | 60 | Right femoral. |
| 16 | " | 61 | Right and left femoral. |
| 17 | " | 44 | Right femoral. |
| 18 | " | 64 | Right femoral. |
| 19 | " | 33 | Right and left femoral. |
| 20 | " | 54 | Right femoral. |
| 21 | " | 22 | Right and left inguinal. |
| 22 | " | 63 | Right femoral. |
| 23 | " | 44 | Right and left femoral (small opening). |
| 24 | " | 64 | Right and left femoral (small opening). |
| 25 | " | 28 | Right and left femoral. |
| 26 | " | 31 | Right femoral. |
| 27 | " | 44 | Left femoral (small opening). |
| 28 | " | 24 | Right femoral. |
| 29 | " | 56 | Right and left femoral and umbilical. |
| 30 | " | 55 | Left femoral. |
| 31 | Female. | 40 | Right femoral. |
| 32 | " | 14 | Right and left femoral. |
| 33 | " | 62 | Left femoral. |
| 34 | " | 54 | Right femoral. |
| 35 | " | 33 | Right femoral. |
| 36 | " | 60 | Right and left femoral. |
| 37 | " | 47 | Left femoral (contained omentum). |
| 38 | " | 56 | Umbilical (contained omentum). |
| 39 | " | 30 | Left femoral (small opening). |
| 40 | " | 43 | Right femoral. |
| 41 | " | 30 | Right femoral. |
| 42 | " | 37 | Left inguinal. |
| 43 | " | 44 | Right femoral. |
| 44 | " | 62 | Right femoral. |
| 45 | " | 7 | Right and left femoral (small opening). |
| 46 | " | 68 | Right femoral and left inguinal. |
| 47 | " | 18 | Left femoral. |

Two hundred bodies examined: In 47 bodies 68 peritoneal diverticula were found; in 16 instances more than one diverticulum was present.

| | |
|---|---|
| 30 males | 1 umbilical.<br>11 inguinal ( 4 double).<br>34 femoral (11 double). |
| 17 females | 2 umbilical.<br>2 inguinal.<br>18 femoral ( 3 double). |

It is a well-known fact that femoral hernia occurs with far greater frequency in women than in men, and, granted that a femoral sac occurs with equal frequency in both sexes, I would suggest that a hernia is more likely to occur in women, mainly for two reasons: (1) because in females the lateral expansion of the pelvis which takes place about puberty would tend to widen the mouth of a peritoneal diverticulum in the femoral region; (2) on account of increased pelvic pressure during pregnancy.

This suggestion receives support from the fact that femoral hernia appears with greatest frequency between the ages of twenty-one and forty-five years, the child-bearing period.

That it is possible, owing to some developmental irregularity, for a peritoneal diverticulum to occupy the crural canal, is clearly demonstrated by the accompanying drawing (Fig. 2), which illustrates an article in the ANNALS OF SURGERY for January, 1909, by Alexander Hugh Fergusson, of Chicago. The patient had suffered from a hernia in his right groin for 27 years. "He dated his rupture to a time when he was eighteen years of age, and was pitching hay on a farm. An extra effort was made with the pitchfork to heave hay, when suddenly he felt something give way in his right groin, and at once a tumor mass appeared in the scrotum."

In the following case, taken from the *Epitome* of the *British Medical Journal* for October 5, 1907, there can be little doubt, from the family history and the operative findings, as to the congenital origin of the hernia.

C. Provera[1] describes the case of a woman of twenty-four who came up for operation with a right crural hernia of a year's standing. Her brother had a right inguinal hernia, and one of her three sisters had bilateral hernia. The patient's tumor was the size of a walnut, painless excepting at the time of the menstrual flow, and reduced itself spontaneously when she lay down. When the sac was found, it had in its outer part a pink, rounded cord, the size of a goose's quill, looped. Light traction on the inner side of the sac brought part of the bladder into view, just at the point where the ureter, here reddened and dilated, entered it. The sac itself contained a little piece of omentum. The operation was performed in the u[illegible]ent made a straightforward recovery; at no time [illegible]l, ureteral, or vesical symptoms. Provera gives an[illegible] of the subject.

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[1] Gorn d. R. Accad. di Med., Turin, 1907, 131.

I ha[illegible]t that if the literature of the subject were c[illegible] a large number of cases would be found [illegible] hernia had first appeared during infancy [illegible]hese mentioned are amply sufficient for the purpose. The earlier in life a hernia appears, the greater the probability of its being due to a developmental defect.

Clinical evidence, then, is strongly in favor of the belief that in a number of cases the sac of a femoral hernia is pre-formed, and is, therefore, the essential cause of the hernia.

The results obtained after operating for the cure of femoral hernia favor the view that the primary cause of the hernia is the presence of the sac; for if the sac were acquired owing to weakness of the abdominal wall, recurrence of the hernia after operation should very frequently take place, as for anatomical reasons it is extremely difficult to strengthen the abdominal wall at this point. Yet we know that most satisfactory results have been obtained after complete removal of the sac alone, without any attempt being made to reinforce the abdominal wall at the site of the hernia.

If, then, in some cases a pre-formed sac does determine the occurrence of a femoral hernia, and in many persons a peritoneal diverticulum persists throughout life, but is so small that the bowel has never entered it, it is surely rational to believe that in all cases and at all periods of life the occurrence of a femoral hernia is due to the fact that a potential hernia sac occupies the crural canal.

Granted the presence of a diverticulum, the descent of the bowel would depend, as in the inguinal or any other region, upon the size of the mouth of the sac. If the sac is a relatively large one, then the hernia may appear during infancy or childhood; if, as is more usually the case, the sac is at first small, then the bowel is not able to enter it, until with the growth of the individual it has attained a certain size

It is generally admitted that the gubernaculum, a fibromuscular mass, is in some way responsible, not only for the descent of the testicle into the scrotum, but also for the descent of the processus vaginalis, which reaches the bottom of the scrotum in advance of the testicle.

About the sixth month of fetal life the gubernaculum extends from the lumbar region through the inguinal canal, and has its chief attachment at the bottom of the scrotum; but bands also pass to the groin and to the root of the penis; others end in the peritoneum.

These additional bands are normally slender, but occasionally are sufficiently developed to influence the direction of the testicle, which may then be found in the perineum, at the root of the penis, or in the crural canal (Lockwood).

Whether it is by muscular action or by cicatricial contractions that the gubernaculum assists in the descent of the testicle and of the processus vaginalis, is still a disputed point, but that it does play a very important part in these changes is rendered probable by the nature of its structure, and by the fact that a remnant of gubernaculum can always be found in the adult, behind the epididymis and the testicle.

In the case of the cruroscrotal hernia above referred to (Fig. 2), it is, I take it, fair to assume that the abnormal descent of the testicle and processus vaginalis was most probably due to the abnormal attachment and development of the crural termination of the gubernaculum.

The evidence that we have, then, justifies us in assuming: 1. That the chief gubernacular band is attached to the bottom of the scrotum, and is responsible for the formation of the processus vaginalis, and for the descent of the testicle. 2. When the testicle together with a process of peritoneum is found to occupy the crural canal, it is probably due to an excessive development of a normally slender gubernacular band.

It is then reasonable to believe that a crural gubernacular attachment, developed in excess of the normal, may, without producing an abnormal descent of the testicle, drag upon the peritoneum sufficiently to make a dimple in the crural region, which, with the growth of the individual, will develop into a potential hernia sac.

The surprising frequency with which crural peritoneal diverticula were found in the bodies examined at Mill Road Infirmary may thus be explained.

The shape of these diverticula and their narrow lumen strongly suggested that they were produced by some force pulling, rather than pushing, the peritoneum outwards.

If the sac of a femoral hernia is formed originally in this way, then some atrophied gubernacular fibres should be found at the fundus of the sac. At the same time it must be remembered that in any case the fibres will be scanty.

A few weeks after I had written the above remarks I secured, in the post-mortem room, from the body of a man sixty-one years of age, the sac of a femoral hernia. I sent the sac to the Clinical Research Association in London, asking that the fundus might be carefully examined for gubernacular fibres. This was done, and on November 30, 1909, I was delighted to receive the following report, together with a microscopic slide: "Sections made longitudinally of the fundus of this hernial sac certainly show small bundles of striated muscle. They can easily be picked out by their characteristic appearance, nuclei, striated sheath, etc." A photomicrograph of the slide is reproduced in Figs. 3 and 4.

So far as I am aware, this is the first time muscular fibres have been demonstrated at the fundus of a femoral hernia sac, but that is only because it is probably the first time they have been looked for there. It is, I hope, reasonable to infer that these muscular fibres are the remains of the gubernaculum, and further that as the scrotal band of these fibres influences in some way the descent of a peritoneal diverticulum into the scrotum, so a crural attachment of gubernacular fibres may in some way determine the formation of a peritoneal diverticulum in the femoral region.

Some of my friends to whom I showed this slide expressed a doubt as to these muscular bundles being gubernacular fibres, chiefly on account of their striation. For my own part, I failed to see how the presence of muscular fibres at the fundus of a femoral sac could possibly be anything else than the remains of the gubernaculum. However, in order to clear up this point, I had the microscopic section, which is reproduced in Figs. 5 and 6, made for me by the Clinical Research Association. It was obtained from an adult, after making a series of sections of the structures immediately behind the epididymis. It represents normal gubernacular fibres in the mesorchium, and the striation of these fibres is seen distinctly.

One would expect striation to be more pronounced in the scrotal band of gubernacular fibres than in the crural, perineal, or any other band, owing to the gubernaculum blending with the internal oblique and transversalis muscles in its descent to the scrotum.

I trust it may be my good fortune to have an opportunity of examining an obturator and a sciatic hernia sac, for I feel confident that, if looked for, muscular fibres will be found at the fundus of both these sacs.

The discovery of gubernacular fibres at the fundus of a femoral sac is, to my mind, very strong evidence indeed of the congenital origin of hernia in this region.

I have not yet had the opportunity of searching for muscular fibres at the fundus of a femoral hernia sac in a woman, but feel confident of finding them there. In the female a structure corresponding with the gubernaculum is responsible for the descent of a peritoneal diverticulum into the inguinal canal, and I believe that in both sexes a crural band of these fibres is responsible for the occasional formation of a peritoneal diverticulum in the femoral region.

I have already explained why femoral hernia is met with more frequently in women than in men, and in conclusion would submit that clinical experience, operative experience, and also evidence obtained from the post-mortem room and from the pathological laboratory are strongly in favor of the view that the sac of a femoral hernia is of congenital origin and not acquired.

# SILVER WIRE AND LINEN THREAD FOR THE CURE OF HERNIA.

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In a former paper[1] the writer drew attention to this "somewhat neglected field of reparative surgery." To the seven cases reported in 1906 he has been able to add many others. The great satisfaction he has received from these cases and the permanency of the results attained have induced him to make a detailed report.

It is just ten years since our attention was first called to the subject of wire filigree almost simultaneously by Witzel and Goepel. Witzel did not use a ready-made filigree. He first partly closed the hernial opening with a few silver sutures, and then covered over the opening still remaining with numerous thin silver wires passed in every direction. This method was good, but rather slow. To Goepel belongs the credit of having first made use of the ready-made filigree. He reported eleven cases of ventral and umbilical, and seven cases of inguinal hernia with sixteen cures. In the other two cases he removed the filigree on account of the formation of a hæmatoma. We now know that this is unnecessary, as the wound will heal even if a hæmatoma develops. Moreover, there may even be some wound infection with subsequent sinus formation, and yet the silver wire or the filigree need not be removed. It need hardly be said that hæmatoma formation is no more likely to result with silver wire than with catgut. Careful hæmostasis and a firm compression dressing will prevent it.

We make use of silver wire in two forms. The one consists of a suture made of fine strands of wire in the shape of a cable. This was devised by Dr. Howard Lilienthal, and we can recommend it most heartily. It is made in various sizes, is much stronger than the ordinary silver wire, much more pliable, and can be tied into a knot with ease. Where the hernial opening is very large we use a filigree made of thin silver wire. We use a filigree somewhat on the order of that described by Bartlett, of St. Louis, in volume xxxviii, ANNALS OF SURGERY, 1903.

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[1] The Use of Silver Wire for the Cure of Large Herniæ, ANNALS OF SURGERY, April, 1906.

To quote from the former paper of the writer:

> "The filigree I have employed has been that devised by Bartlett, and I have followed his directions closely. He advised the use of the ready-made filigree, made of thin wire, not heavier than gauge No. 30. The heavier wire is not resilient enough, and does not adapt itself so well to the tissues, and in consequence it is apt to cause irritation. Another advantage of the filigree over silver-wire sutures is the fact that it can be introduced very quickly. Furthermore, and this is a matter of great importance, the filigree can be placed between the tissues at a much greater distance from the edges of the opening than would be possible in passing a needle. It should widely overlap the hernial opening on all sides. No sutures are required to hold the filigree in place. If any one doubts the correctness of this statement, he has but to remember what happens when we inadvertently leave a piece of gauze in a wound. How quickly are the meshes of the gauze filled with granulation tissue, which anchors it in place so firmly that it can only be removed with the greatest difficulty. The same process goes on with the filigree. In a few weeks it is so firmly anchored in place that great force is required for its removal. This has been proven experimentally on animals. Another advantage in not suturing the filigree in place is the fact that it can then better adapt itself to the surrounding tissues, and there is less likelihood of its causing irritation. If properly made and properly inserted it should cause no discomfort whatever; the patient should not be aware of its presence. . . . As is well known, scars in the abdominal wall generally spread most in a lateral direction. The filigree, which can be readily made by any one, depends for its efficacy upon the fact that all but one of the wires run across the long axis of the hernial opening. The filigree should overlap the opening by at least an inch all around. It is so made that each cross wire ends in a loop, thus obviating sharp ends. If sutures of silver wire are used, they should not attempt to approximate the tissues (a frequent cause of failure). It is always better to depend on two layers of silver; either two filigrees in two different planes, or one filigree and one reinforcing layer of silver sutures, provided the superficial muscles or fascia can be approximated without any tension. In general it is well to place the filigree as deeply as possible; sometimes it is not necessary to open the peritoneal cavity. But the filigree must extend well beyond the hernial opening on all sides. This necessitates dissecting up the muscles all

around before introducing the filigree. Then the superficial plane of muscles or fascia may be united with silver-wire sutures, or a second filigree is introduced. Or a filigree can be made by a running suture of wire that does not approximate the tissues, but simply fills the gap. By following this method we have a double guard against recurrence of the hernia."

The filigree should be so pliable that it will bend with respiratory movements. It will then accurately mould itself during the healing process to the locality in which it is placed, and it will not cause any local irritation, which would necessitate its removal. The meshes should not be too close and the wire should not be too heavy. It is surprising how well such a flimsy looking filigree, when it has healed into the tissues, will prevent the recurrence of a hernia. The writer has several cases that have been doing severe physical labor for four and five years, in perfect comfort, and without any relapse. If such cases are examined a few months after operation it is impossible to feel any part of the filigree, so effectually has it become imbedded in the tissues.

The indications for the use of silver wire will vary with the individual operator, and some surgeons never use it. A recent English writer, McGavin, uses it in old people with large hernial openings, in people who habitually throw an extra strain on their abdominal muscles, in patients with poorly developed abdominal muscles, and finally in recurrent herniæ. To these groups of cases we would add one other, cases in which the muscles and fascia cannot be approximated without tension.

In recurrent cases, if the first operation was properly done and the wound healed by primary union, then a second Bassini operation done on the same tissues is not likely to be permanently successful. Where Poupart's ligament or the oblique muscles, or both, are poorly developed, it is not fair to expect any better result the second time than the first, if the ordinary suture material is employed. We have been using silver cable sutures in these cases with good results. We have also used a filigree in a few very large inguinal herniæ. Even if we succeed in dragging the attenuated oblique muscle over to the poorly developed Poupart's ligament, is it not asking too much to expect some tissues to permanently prevent the reformation of a hernia? Even using the rectus muscle or its sheath is in many cases unsatisfactory. And yet we have seen surgeons do a third, or even a fourth Bassini operation (with catgut) for recurrences. Each time they went through the form of a typical operation, using the same poorly developed tissues that nature had unmistakenly declared to be unfit for the work at hand.

Why there should be a sentimental objection to putting a so-called foreign body into the wound, in the shape of silver sutures or a filigree, we have never been able to understand. And why some men prefer to do most extensive plastic operations for the cure of herniæ, which often fail to give a permanent cure however pretty they may look on the table, in place of the simple and reliable procedure of using a filigree, is also hard to understand. For after all we are not dealing with a matter of sentiment, nor is our object the doing of a pretty piece of work. Our problem is rather the plain and prosy one of curing a large or a recurrent hernia, where the anatomical conditions are such that autoplastic operations do not give much chance for radical cure. The usual objection we hear is that the filigree will irritate and will have to be removed. The answer to this, in the light of our experience, is very simple. If the proper wire is used in the first place, if the filigree is properly made in the second place, and if it is properly introduced in the third place, it will very seldom be necessary to remove a filigree. Personally we have only once been compelled to remove one, where it was introduced as a ready-made filigree. In no case have we had to remove a filigree when made of running sutures of wire. In some of our cases there has been some superficial infection of the wound, especially in fat patients, due to trauma of the fat. In such cases a sinus has remained for a longer or shorter period, but except in the one case referred to above we have never removed the filigree or the wire sutures, and the wounds have all healed. In the majority of cases, with proper materials properly employed, our wounds have healed as rapidly as in cases in which we have used absorbable sutures. Where the filigree is made of running sutures, the silver cable wire devised by Dr. Lilienthal will be found much more satisfactory than ordinary silver wire. Where there is much gaping of the tissues, no attempt is made to approximate them. The gap is filled by running sutures back and forth in figure-of-eight style. In some cases a filigree made beforehand may be used. This may be placed between the peritoneum and transversalis, or the filigree may be used in a more superficial plane.

Case I.—Israel M., fifty-three years old, was first admitted to Mount Sinai Hospital in November, 1902. There had been a gradually increasing right inguinal hernia for three years. The hernia had been irreducible for one year, and there had been several attacks of abdominal pain. The hernia, on admission, was 58 cm. in circumference and was only partly reducible. On opening the sac, Dr. Lilienthal found it to contain small intestine, cæcum, and ascending colon, the latter firmly adherent to the sac. The adherent appendix was removed. The sac was so firmly adherent to the cord and testis that their detachment was impracticable. Testis cord and part of the sac were removed; the intestines were replaced, and the neck of the sac closed with chromic gut. No sutures were used; the wound was packed with gauze and a compression bandage was applied. During convalescence there was some sloughing of the fascia and of the deeper tissues. A large exudate which formed in the scrotum required incision. The man left the hospital after two and a half months, wearing a truss. Six months later he returned to the hospital. The hernia could no longer be retained by a truss; it was only partly reducible and prevented the man from earning a living. The dangers of a radical operation were explained to him, but he begged to have it done. On August, 1903, I excised the scar tissue and opened the sac. The many coils of small intestine could not be reduced until the patient had been placed in extreme Trendelenburg's position. Even then it was very difficult. The sac was freed from adhesions and tied off. The inguinal canal was so large that it was impossible to close it with sutures. The ring was narrowed by a purse-string suture of silver wire. A filigree was now placed over the inguinal canal, and the superficial fascia and skin brought together with sutures. Following the operation we attempted to keep the foot of the bed elevated, but unfortunately this caused nausea, retching, cyanosis, and dyspnœa. Although the bowels moved daily, the man was always restless and uncomfortable. Three days after operation he began to vomit, restlessness and cyanosis increased, and six days after operation he died. Examination showed that the filigree was in place and that there had been no infection whatever. Death was caused by the fact that the abdominal cavity could not accommodate itself to the large amount of intestines that had been in the sac.

Case II.—Mrs. Ray M., thirty-four years old, was referred to me by her physician. In October, 1900, she had been operated on by the late Dr. Bull, who removed diseased adnexa through a median incision. A hernia developed in the scar five months after operation A few months later there was a sudden attack of pain in the right side of the abdomen, accompanied by vomiting and fever. This attack was followed by similar ones. The hernia increased in size, it became painful, and the truss no longer retained it. Operation, October 27, 1904. The sac contained a large mass of omentum. The omentum was replaced, the appendix removed, the sac dissected out and tied off. The peritoneum was closed with a running catgut suture. The posterior sheaths of the recti and the muscles themselves were approximated with chromic sutures. It was not possible to close the opening in the fascia entirely. With silver-wire sutures passed from side to side to form a filigree, the gap was filled in. The skin was closed with silk. The wound healed by primary union. Five and a half years have elapsed since this operation was performed, and the patient has been perfectly comfortable and has had no relapse.

Case III.—William K., thirty years old, admitted January 6, 1905. There had been an oblique right inguinal hernia for three years, and a similar hernia on the left side for one year. Operation on the right side by Dr. Lilienthal. For the Bassini sutures twisted silver-wire sutures were used. The operation on the left side was performed by the writer. There was such a wide separation of the deeper structures that it was impossible to approximate them. The gap was bridged over by a running silver suture, returning the suture so as to make a sort of figure-of-eight filigree. The superficial fascia and skin were sutured separately. Both wounds healed by primary union.

Case IV.—Louis R., thirty-seven years old, admitted May 5, 1905. Two months before admission the man, while getting off a moving car, was thrown against a steel column. He sustained a fracture of the humerus, dislocation of the clavicle and three upper ribs, and a large ventral hernia in the left iliac fossa. On May 9 I performed a partial excision of the clavicle and three upper ribs. Eight days later I exposed the ventral hernia through a three-inch transverse incision. The peritoneum was not opened. A silver filigree two by three and a half inches was placed between peritoneum and transversalis. The external oblique was approximated with a running silver-wire suture and the skin with silk. The wound healed by primary union. The man has not suffered any discomfort from the wire.

Case V.—Tony M., twenty-four years old, admitted July 10, 1905. In 1901 there had been an operation for appendicitis. A year later a hernia developed in the scar; it had always been reducible until two weeks before admission. At that time the hernia suddenly became larger and vomiting set in. The hernia was five inches wide and three inches long. On the surface of the mass there were several small ulcers. Operation, July 12, 1905. Hernioplasty with resection of gut, for large ventral hernia with gangrene of gut. The hernia consisted of several loops of firmly adherent small intestine. One loop had perforated the skin and formed the large ulcer on the surface of the skin. On account of its poor condition six inches of this loop, together with the adherent skin, were resected. End-to-end anastomosis with the Connell suture was done. The circulation in the adjacent loop of gut was not very good, and two pieces of rubber dam were placed around the suture line. As the patient's condition was poor, and as the operation had already consumed considerable time, it was decided to use silver wire to close the abdominal wall. The hernial ring was freed and through-and-through silver-wire sutures were passed from side to side. In this way the greater part of the wound was closed. The drains emerged from the centre of the ring. The skin was closed with silk. For two weeks there was a slight fecal discharge from the wound. Thereafter the wound healed steadily, and the patient left the hospital with a healed wound on August 16, 1905. Since then the girl has been doing arduous housework, including lifting of heavy weights, without any pain or discomfort.

Case VI.—Golde B., thirty years old, admitted October 3, 1905. The patient had an umbilical hernia of five years' standing. Five days before admission the hernia had for the first time become irreducible. The bowels could not be moved and vomiting set in. The hernia was the size of an orange, tense, and tender. Operation on October 3, 1905, immediately after admission. The sac contained omentum and one loop of small intestine. The gut was replaced and the omentum resected. Three sutures of silver wire almost completely obliterated the diastasis at the neck of the sac. A few catgut sutures approximated the superficial tissues. A small cigarette drain was introduced and the skin closed with silk. The wound was entirely healed in sixteen days. It would not have been possible to have brought the fascia together in any other manner. Three months later, after a severe attack of bronchitis, the patient developed a small hernia just below the umbilicus. Had a filigree been put in besides the wire sutures, this would probably not have occurred.

Case VII.—Mary M., twenty-seven years old, admitted October 3, 1905. Two weeks before admission the woman noticed a mass in the right hypochondrium and epigastrium. The mass was hard, smooth, adherent to the abdominal wall, and measured about three by five inches. The tumor was excised through a vertical incision in the right hypochondrium. It involved the right rectus and the adjacent portions of the oblique muscles; it was also adherent to the parietal peritoneum. Portions of the oblique muscles, the rectus, including both its sheaths, and the adherent peritoneum were removed, together with the tumor. It was only with difficulty that the peritoneum could be brought together with catgut sutures. A filigree was then placed in the depth of the wound, and a second filigree made by passing running sutures of silver wire through the oblique muscles. A drain was placed at either angle and the skin approximated with zinc oxide plaster. The pathologist, Dr. Mandlebaum, reported the tumor to be an inflamed fibroma. Recovery was rapid and uneventful.

The above seven cases were reported by the writer in his previous paper referred to before. The cases reported below have been operated upon by the writer since 1905. They form but a small proportion of the total number of hernia cases which he has operated on by other methods during this time. But, with increasing experience, silver wire is being used by him in a larger proportion of the cases with the most gratifying results.

We wish to state here that during the past eighteen months we have entirely discarded chromic catgut in hernia cases. We were led to this step by seeing several hernias, done by competent surgeons, that recurred within six weeks after the time of operation. All these cases had been simple cases of inguinal hernia which had healed without any infection. After giving the matter some thought, we came to the conclusion that this unfortunate condition could be explained in only two ways: either the catgut knots opened as the result of coughing or vomiting, or the catgut was absorbed too soon and allowed a recurrence. The writer had also frequently noticed at operations that some strands of chromic gut were very brittle, and sutures sometimes had to be passed several times before a good strand was found.

All these facts induced the writer to discard chromic gut in hernia cases. Where a patient's welfare and the success of an operation are to so great an extent dependent on the suture material, it has seemed to us that we should use the safest material we can find. Catgut, no matter how prepared, is not safe. But we have a material which is easily prepared, which is always sterile, which is never quickly absorbed, and with which the knots never open spontaneously. We refer to Pagenstecher linen. We have used this in over 100 operations, most of them herniotomies. Among these cases we have as yet seen no recurrence. We use No. 2 or No. 3 size, and seldom have it tear. It does not irritate the tissues, almost all the cases have healed by primary union, and they have stayed healed. We were warned when we began this work that in many cases we would be compelled to remove knots. Fortunately this has not happened. Our wounds have healed just as satisfactorily as when we used catgut. In only a single case were we compelled to remove any sutures. That was in the case of a physician, who was very fat, on whom we did a difficult hernioplasty. He developed a fat necrosis (undoubtedly due to trauma at the operation), a sinus remained until we removed the linen sutures under local anæsthesia six weeks after operation. This case is also free from recurrence. In not another case were we compelled to remove any of the linen sutures after operation. The more we use the material, the more pleased we become with it. It is certainly a satisfaction at the time of operation to know that we are using sutures that will not be absorbed too soon. If we have a recurrence after the use of linen sutures, we can say with certainty that the material is not to blame, and many recurrences after the use of chromic gut can, we firmly believe, be correctly attributed to the catgut. So that in all simple hernia cases, whether inguinal, femoral, or ventral, we use linen sutures. In all recurrent cases we use silver wire. The linen is wound on glass spools, boiled for fifteen or twenty minutes, and preserved in 95 per cent. alcohol.

We have not reported in detail any of the cases in which linen sutures were employed, as they ran the same course as cases where catgut was used. All the case reports in this paper deal with cases in which silver wire, in one form or another, was employed.

Case VIII.—Israel F., sixty-two years old, admitted February 26, 1906. There had been a right inguinal hernia for ten years and a left inguinal hernia for two years. The man had worn a truss for many years. Both herniæ were reducible. Operation February 27, 1906, under local anæsthesia. Right side: The intestine in the sac was reduced and the sac resected. Both the internal oblique and Poupart's ligament were very atrophic and relaxed and there was a wide hiatus between them. The upper angle was closed with chromic gut, but it was impossible to close the lower part of the wound, on account of the wide separation. Accordingly, a running suture of silver wire was introduced to form a filigree. No tension was made on this suture and no attempt was made to drag the tissues together.

Catgut was used for the aponeurosis and silk for the skin. Left side: Similar anatomical conditions were found and a similar operation was performed. Both wounds healed by primary union, and the man went home on March 16.

Case IX.—George E., fifty-five years old, admitted October 4, 1906. The man had had a left inguinal hernia for many years. During the past two years it had been only partly reducible and had been increasing in size. The right ring admitted one and a half fingers, and there was an impulse on coughing. On the left side there was a hernia as large as a child's head, containing many loops of gut, which could be returned only with difficulty. Operation, October 5, 1906. The sac was opened and the loops of small intestine reduced. The transverse colon and the sigmoid were adherent to the sac and were reduced only after the adhesions were divided. Extensive dissection was required to free the sac, which was tied off with a chromic gut suture. It was not possible to suture the conjoined tendon to Poupart's ligament on account of the wide diastasis. They were approximated by two running sutures of silver-wire cable sutures. To strengthen the wire it was braided with a piece of chromic gut (a good device). The fascia was sutured with chromic gut, the skin with silk. A small tube drain was placed in the scrotum. The wound healed by primary union, and the patient left the hospital on October 21.

Case X.—Sarah K., thirty-three years old, admitted January 9, 1907. Two years before admission the patient had had both ovaries removed. One year before that an umbilical hernia had appeared, which slowly increased in size in spite of a truss. Four months before admission a hernia showed itself in the median cœliotomy scar; this became gradually larger. On examination, we found a small umbilical hernia containing adherent omentum. Below the umbilicus there was a scar from a median wound which had evidently been drained at its lower angle. Just to the right of this scar there was a reducible hernia as large as a fist. January 11, 1907, hernioplasty for umbilical and ventral hernia. A median incision was made, starting above the umbilicus and extending to within two inches of the pubis. Adherent omentum at the umbilicus was resected and the umbilicus excised. The fascia and muscle surrounding the ventral hernia were then dissected free, disclosing a hiatus of four inches with very thin fascia. The peritoneum was closed with catgut. The deep fascia and muscle were together approximated with chromic gut, the muscle thereby being placed under considerable tension. A silver-wire filigree was placed over this suture layer, and a running suture of silver cable wire was passed through the edges of the superficial fascia in the form of a filigree, as approximation was not possible. The deep layer of the fat was closed with a few catgut sutures. A split rubber tube was placed at either angle of the wound and the rest of the wound strapped with zinc oxide plaster. Time of operation was fifty-five minutes. The patient developed a postoperative pneumonia, which caused her death four days after operation.

REMARKS.—To-day I would not make any attempt to suture muscle and fascia in a case of this kind. After closing the peritoneum I would place a filigree between the peritoneum and the deep fascia, and a second filigree between the superficial fascia and the muscle. Such an operation could be done in half an hour and the danger of a pneumonia minimized. We believe that the deaths from pneumonia, following operations for umbilical hernia in fat patients, will be much fewer if less extensive dissections and shorter operations be undertaken.

CASE XI.—Abraham K., twenty-two years old, admitted June 26, 1907. The man had been operated on by another surgeon two years previously for a right inguinal hernia. The typical Bassini operation had been done, chromic gut sutures had been used, one suture having been passed above the cord. The wound had healed by primary union. We found a small reducible recurrent inguinal hernia on the right side. Operation June 28, 1907. The sac was excised and the cord freed; the recurrence was at the lower angle. Three silver-wire sutures were passed over the cord, uniting the muscle to Poupart's ligament. Two additional chromic gut sutures were passed above and below the silver sutures. The fascia was united with catgut, the skin with silk. On the left side a large ring was found and a considerable gap between the muscles and Poupart's ligament. These tissues were united over the cord with chromic sutures. Both wounds healed by primary union, and the man left the hospital July 11. 1907.

Case XII.—Louis H., thirty years old, admitted July 5, 1907. The man had a congenital inguinal hernia on the right side, and a direct inguinal hernia on the left side. On the right side Ferguson's modification of the Bassini operation was done with chromic gut for the deep sutures. On the left side there was a direct hernia through the transversalis fascia. The upper half of the wound could be closed with chromic sutures, but below there would have been too much tension. Accordingly two sutures of silver wire were passed in the form of a filigree. The aponeurosis was united with catgut, the skin with silk. The wounds healed by primary union, and the patient went home on July 22.

Case XIII.—Israel M., forty-five years old, admitted July 11, 1907. The man had had a right inguinal hernia for six months. The right ring admitted two fingers, and there was a bulging on coughing. The left ring also admitted two fingers, but there was no impulse on coughing. Operation July 12, 1907. Right side: A small sac found and tied off. Poupart's ligament was very thin. Two chromic sutures were used at the upper angle and four silver-wire sutures below them. Catgut was used for the aponeurosis, silk for the skin. Left side: No sac was found. The cord was buried by six chromic sutures. The man was discharged after a normal convalescence on July 29.

Remarks.—Where the ring on the side opposite to a hernia is large we habitually close the ring at the time of operation, as we have found that many of these cases return a year or two later with a hernia on the opposite side, if this precaution is not taken. This step takes but a very few minutes, and we readily get the consent of both hospital and private patients when we explain to them the dangers of a subsequent hernia on the opposite side.

Case XIV.—George N., eighteen years old, admitted July 22, 1907. In February, 1907, the man had been operated on for an infantile inguinal hernia. Soon after leaving the hospital he had noticed a recurrence. The writer had performed the original operation, using six No. 2 chromic sutures. The wound had healed by primary union, the temperature never exceeding 100° F. He had been kept in bed 14 days and had been in the hospital 20 days. On examination we found a reducible hernia. Operation July 24, 1907. A large sac was found which was dissected from the surrounding tissues. Poupart's ligament was in such poor condition that it was out of the question to use it for a radical cure, so the fascia lata was exposed. The internal oblique muscle was sutured to Poupart's ligament and to the fascia lata by a running silver-wire cable suture. The aponeurosis of the external oblique was closed with catgut, the skin with silk. Time of operation, 35 minutes. The wound healed by primary union, and the man was discharged on August 8.

Case XV.—Philip P., forty-two years old, admitted December 30, 1907. The man had been operated on twice for a left inguinal hernia, the first time at the German Hospital in Philadelphia, in 1905, and the second time at Mt. Sinai Hospital in the following year. The man stated that three months after his second operation the hernia had again recurred. It had always been easily reducible, and he had not worn a truss. The external ring was one and a half inches in diameter, and the hernia descended to the upper part of the scrotum. Operation, January 3, 1906. The sac contained omentum which was resected. Both the oblique muscles and Poupart's ligament were very poorly developed. The sac was excised. The cord was buried by several silver-wire cable sutures, uniting internal oblique and Poupart's. Chromic gut was used for the fascia and silk for the skin. The wound healed by primary intention.

Case XVI.—Samuel M., twenty-three years old, admitted January 14, 1908. The man had a left inguinal hernia of three months' standing. The sac, as well as the contained omentum, were resected. Both the conjoined tendon and Poupart's were so poorly developed that the deep chromic gut sutures were reinforced by three silver-wire sutures. The fascia was closed with catgut, the skin with silk. Recovery was uneventful and the patient went home on February 5.

Case XVII.—Nathan B., fifty years old, admitted January 23, 1908. Eight weeks before admission a left inguinal hernia developed. Five years before, after lifting a heavy weight, a hernia developed on the right side. Operation, January 27, 1908. On the right side a large hernial sac was excised. Bassini sutures of chromic gut were used, plain catgut for the fascia, and silk for the skin. On the left side a sliding hernia was found. The muscles were poorly developed, and accordingly silver wire was used for the deeper sutures. Otherwise the operation was done as on the right side.

Remarks.—To-day the writer would be afraid to trust to chromic sutures in a case like this. He would use linen sutures on the right side, and silver sutures on the left side.

Case XVIII.—Max S., thirty years old, admitted February 8, 1908. Three weeks before admission a left inguinal hernia was noticed. The inguinal ring barely admitted the tip of the index finger. Overlying Poupart's and almost as long as it, there was a mass which increased in size on coughing and which gave an impulse. The abdominal muscles in this region were thin, and at times it seemed as if there was a protrusion through them. Operation, February 10, 1908. The omentum in the left hernial sac was resected. Poupart's, except near the pubes, was absent and was replaced by a thin layer of muscular fibres. The cord, which was poorly developed, was buried by several chromic sutures, uniting the muscle to the crural fascia at the outer part, and several silver-wire sutures were used to sew the muscle to the periosteum of the pubes and also to Gimbernat's ligament. Catgut was used for the fascia and silk for the skin. Recovery was uneventful.

Case XIX.—Koppel R., forty years old, admitted February 27, 1908. The patient had been operated on at Mount Sinai Hospital by another surgeon three months before his readmission. At that time he had stated that he had had a double inguinal hernia of three years' standing. It had always been possible to retain the herniæ with a double truss. The typical Bassini operation had been done on one side, and the Ferguson modification on the other. Chromic gut had been used for the deep sutures, and both wounds had healed by primary union. The man returned to the hospital, stating that five or six weeks after the operation he noticed, on coughing, a small protrusion on the right side. On the left side he had the feeling as if something protruded on coughing. On examination both rings were found enlarged, the right more than the left, and a small protrusion was felt on both sides, more on the right. Operation, March 3, 1908. Right side: A large opening was found at the centre of Poupart's, readily admitting a finger. There were no muscular attachments to the inner four-fifths of Poupart's, only a small slip of internal oblique was attached to the outer fifth. Four silver-wire cable sutures were used to unite the internal oblique and transversalis to Poupart's, the last one passing through the periosteum of the pubis. The fascia was united with chromic gut, the skin with silk. Left side: The internal oblique was attached to Poupart's only over its outer half. The inner half was entirely free from muscular attachment. No hernial sac was found. A similar procedure to that done on the right side was carried out. Both wounds healed by primary union.

REMARKS.—A double recurrence in six weeks in a case like this, in which both wounds had healed by primary union and in which the operation had been performed *lege artis*, means one of two things: either the chromic sutures were absorbed too soon, or the knots of the sutures opened as the result of coughing or vomiting. The writer did not do the first operation in this case, but he has seen several similar cases done by different surgeons, and he has had one similar case of his own:

Bernard W., forty-two years old, admitted April 29, 1908. Two months before his admission to the hospital the man had been operated on at another hospital in this city for a double inguinal hernia. Shortly after his return home a recurrence took place on the left side. The man refused another operation.

Such cases (and they are not so rare) are a most potent argument in favor of using linen sutures.

The case is reported as being another early or rather immediate recurrence after the use of chromic gut. There had been no wound infection in this case.

CASE XX.—Nathan W., twenty years old, admitted August 4, 1908. In November, 1907, the writer operated on this man for a bilateral hernia. On the right side he had found a large sac, and on the left side a small one. Chromic gut had been used for the deeper sutures. With the exception of a slight superficial stitch-hole infection, convalescence was normal, and the man had left the hospital with both wounds healed two weeks after operation. On readmission the patient stated that immediately after he returned home he had noticed a small protrusion, which gradually increased in size, in the region of the scar on the left side. A month before his readmission he noticed a swelling on the right side, which rapidly increased in size, gradually working its way down into the scrotum. On examination we found both herniæ easily reducible. Both inguinal rings admitted three finger-tips. Operation, August 7, 1908. Right side: The contents of the sac were reduced except one loop of gut broadly adherent to the sac at its neck. This was dissected free and the sac resected. The poorly developed conjoined tendon was sutured to the equally poorly developed Poupart's by a running silver-wire suture. Catgut was used for the aponeurosis and silk for the skin. Left side: After reducing the hernial contents the sac was resected. The conjoined tendon was fairly well developed, but Poupart's was very thin. A running silver-wire suture united these two structures. Both wounds healed kindly.

REMARKS.—As in the cases reported above, the chromic gut was evidently at fault, as the recurrence on one side took place immediately after the return home of the patient. It is interesting to note that both this case and Case XVIII were operated on in November, 1907. At that time our chromic gut was evidently too rapidly absorbed and allowed such early recurrences. In Case XIX we have the additional features of poorly developed Poupart's ligaments on both sides and poorly developed muscle in addition on the right side. Had this case been sutured with silver wire in the first instance, a recurrence would probably not have taken place.

CASE XXI.—Rebecca G., fifty-four years old, admitted August 8, 1908. The patient had had a double inguinal hernia from childhood. She had been operated on at a Newark hospital in 1905. Four weeks later a recurrence took place on both sides, larger on the left side than on the right. The left hernia steadily increased in size, with occasional symptoms of mild obstruction. On examination we found a large reducible left inguinal hernia with a ring that admitted three fingers. On the right side the ring was equally large, but the hernia was smaller than on the opposite side. Operation, August 10, 1908. Left side: The sac was adherent. All the contained small intestines were reduced except one loop which was adherent by a broad band at the bottom of the sac. This band was divided and the loop returned. The sac was then excised. The conjoined tendon was poorly developed. Poupart's ligament was flabby and showed no evidence of having been sutured at the previous operation. With six silver-wire sutures the fairly well-developed rectus muscle was sutured to Poupart's, each suture taking as much as possible of the conjoined tendon. In this way both conjoined tendon and rectus muscle were used to close the canal. The external oblique was closed with catgut, the skin with silk. The patient did not want to have any operation done on the opposite side.

Remarks.—Here again we probably have to deal with a case in which the chromic gut was absorbed too soon or the knots opened, and the patient had a double recurrence in four weeks. The muscle had been in contact with Poupart's for so short a time that at our operation, done three years later, no evidence of its having been sutured could be found. Such cases of very early recurrence after the use of chromic gut are not so rare as we have been led to think. The writer has seen enough of them at the hands of various surgeons to strengthen his conviction that linen is a far better suture material in hernia cases than chromic gut. In a hundred cases of hernia in which linen was used for the deeper sutures, the writer has as yet not seen a single recurrence. He does not mean to say that recurrences will not occur after the use of linen, but he does mean to say most emphatically that they will occur less often than when chromic gut is used.

Case XXII.—Barbara G., thirty-eight years old, admitted January 2, 1909. The patient had been operated on for double inguinal hernia by another surgeon in 1904. Five weeks after the operation, which was done with chromic gut, a recurrence took place on the right side. The hernia had always been reducible after its recurrence, until one week before the patient came to the hospital. At that time the hernia became painful and irreducible. The day before operation vomiting set in. We found an irreducible right inguinal hernia as large as a plum. Attempts at taxis were unsuccessful. Operation, January 2, 1909. The hernia was reduced under anæsthesia. The sac was resected. Poupart's ligament was very poorly developed. Five sutures of silver-wire cable were used to unite the conjoined tendon to Poupart's over the cord. The fascia was sutured with chromic gut, the skin with silk. The patient left the hospital on January 20, after an uneventful convalescence.

Remarks.—We have here another immediate recurrence after a herniotomy, done by another surgeon with chromic gut. It is true there was an additional complication in this case, in a poorly developed Poupart's. But do not most surgeons use chromic gut in cases of this kind, even where the muscles and the ligament are poorly developed? Are such cases not much more suitable for linen or silver sutures?

Case XXIII.—Anna J., twenty-six years old, admitted June 6, 1909. The patient was the sister of a physician. She had been operated upon by Murphy, of Chicago, for appendicitis in 1897. A large ventral hernia, partly reducible, had developed in the scar. Operation, June 17, 1909. The old scar was excised and the peritoneum was found adherent to the skin. The hernial opening was three inches long and two inches wide. By dissection the rectus muscle was exposed on the inner side and the retracted fascia and muscle on the outer side near the anterior superior spine. The incision was about seven inches long. Adhesions between the uterus and the anterior abdominal wall were divided. Two inflammatory cysts were removed from the left iliac fossa. The right tube and ovary had been removed with the appendix. Adhesions between the uterus and bladder were broken up and a piece of chromicized Cargile membrane placed between these two organs. The peritoneum was closed with chromic gut. The muscle and fascial flaps were dissected back far enough on either side to admit placing two silver-wire filigrees, each three by five inches, between the peritoneum (which had been sutured) and the fascia. Muscle and fascia were now sutured over this filigree but not approximated, except at the two angles (where there was no tension) with silver-wire sutures. The skin was closed with silk. The wound healed by primary union, and the patient was able to leave the hospital in two weeks. As this was a private case, we were able to follow it carefully. In spite of the large amount of silver wire employed in this case, the patient suffered no discomfort therefrom. The wound has remained solidly healed. We doubt very much whether we could have obtained as satisfactory a permanent result with any other suture material.

Case XXIV.—Pauline D., twenty-five years old, admitted

March 29, 1909. Nine months before admission, after a difficult labor, an umbilical hernia developed. The hernia was easily reducible, though it was gradually increasing in size. The patient had endocarditis and nephritis; there was marked dyspnœa on exertion and frequent œdema of the feet. Operation, March 31, 1909. The abdominal wall was remarkably thin. The small sac was resected after the contained omentum had been replaced. Owing to the condition of the patient's heart and kidneys, we decided to do a rapid operation and avoid extensive dissection. The thin musculo-aponeurotic layer was broadly overlapped by a running suture of silver wire. The skin was closed with silk. After a normal convalescence the patient left the hospital on April 19.

Case XXV.—Dora E., fifty-four years old, admitted May 31, 1909. This was a private patient who had an umbilical hernia of many years' standing. The hernia has increased in size with each pregnancy. It had been irreducible for several years, and at times very painful. On examination we found an irreducible umbilical hernia the size of a man's fist. The whole surface of the hernia was inflamed, and at the most prominent part there was an ulceration probably due to rubbing of the clothing. Operation, June 1, 1909. The ulcerated area was cauterized with carbolic acid, followed by alcohol. Omentum was found adherent in several pockets. The omentum and the sac were resected. The peritoneum was closed with chromic gut, the fascia was overlapped from side to side with silver-wire sutures. A slit rubber tube was placed at either angle of the wound. There was primary union of the wound. The patient was discharged in fifteen days.

Case XXVI.—Nathan B., sixty-five years old, admitted September 27, 1909. The patient had worn a truss for twenty-five years for a right inguinal hernia. He had recently noticed a slight swelling in the left groin. We found a large irreducible scrotal hernia on the right side, and a small reducible inguinal hernia on the left side. Operation, September 29, 1909. Hernioplasty for hernia of bladder. A large sac was found on the right side, and closely adherent to it the urinary bladder, which had prolapsed through the inguinal canal. The bladder was separated from the sac without injuring it. The sac was opened and its contents reduced. The sac was then excised and the bladder returned to its normal position. The muscles were very much atrophied from the many years' use of the truss. Bassini sutures of silver wire were used, the cord being buried. To reinforce a weak area in the muscles, a silver-wire filigree, one by three inches, was inserted. The fascia was sutured with chromic gut, the skin with silk. A postoperative hæmatoma in the tunica vaginalis broke down and caused a profuse purulent discharge. The patient left the hospital on October 27 with a sinus that has persisted, although the discharge has become very scanty.

Case XXVII.—Max R., twenty-two years old, admitted February 12, 1910. The patient had been operated on by another surgeon in 1905. The abstract of his history at that time was as follows: "Since 1898 the patient had had a reducible right inguinal hernia. The right ring admits two fingers, the left ring the tip of the index finger. Operation, March 16, 1905. A typical Bassini operation was done on the right side. On the left side no sac was found and the internal oblique was sewed to Poupart's. Chromic gut was used on both sides. The left side healed by primary union, the right side became infected." From the time the patient left the hospital until six months before his readmission he was well. He then noticed a bulging in the left inguinal region, which was easily reducible. We found a small hernia in the scar on the left side, the side that had healed by primary union. The right side, in which there had been some infection, showed no evidence of recurrence. Operation, February 10, 1910. A left inguinal hernia was found with the sac adherent to the cord. The sac was resected, and the conjoined tendon sewed over the cord to Poupart's with five silver-wire sutures. Convalescence was uneventful.

Case XXVIII.—Abraham A., fifty-one years old, admitted February 14, 1910. Two years before admission a right inguinal hernia had developed. This had gradually increased in size until walking had become almost impossible. We found a right scrotal hernia, as large as a cocoanut, consisting largely of gut, which was easily reduced. The ring was large and admitted three fingers. On the left side there was an incomplete indirect hernia, with a marked impulse on coughing. Operation, February 16, 1910. Left side: The sac contained omentum and small and large intestine. The contents were reduced and the sac resected. To close the canal five silver-wire sutures were used, and in between these several sutures of linen. Right side: A similar operation was done. The sac was not so large, and only five silver-wire sutures were used to unite the conjoined tendon and Poupart's. Both wounds healed by primary union and the patient went home on March 17.

Case XXIX.—Louis G., four years old, admitted February 26, 1910. The child had a congenital left inguinal hernia and undescended testis. The testis could be felt in the lower part of the inguinal canal, and could be brought down into the scrotum. The hernia was as large as an egg; it was easily reduced. The mother stated that another child in the family had a double congenital inguinal hernia. Operation, February 28, 1910. A fairly large sac was found. Both the oblique muscles and Poupart's were very poorly developed. On this account six silver-wire sutures and three linen sutures were used to join the conjoined tendon to Poupart's. We followed our usual technic and left the cord lying posterior to the suture line. The child left the hospital with a healed wound on March 19.

Hernias form so large a proportion of our surgical cases, and yet it would almost seem as if we did not give them as much thought and study as they deserve. We seem to have fallen into a rut these past ten years and do our herniotomies by rule of thumb. Is it not time to call a halt on the promiscuous use of chromic gut in herniotomies? Have we not been worshipping a fetich too long? It is true that we had unsatisfactory results with silk sutures. The knots irritated and often had to be removed. But this is not true with Pagenstecher linen. We can report a hundred cases, and in only one did we have to remove any sutures; and that in a case of fat necrosis, where catgut sutures would probably also have had to be removed.

The startling number of immediate recurrences after the Bassini operation with chromic gut, in which the original operation was done by various surgeons (and once by the writer) reported above, are surely worthy of serious consideration. They cannot be argued away. It is idle for a surgeon to say that this does not happen to him. The various surgeons that did the original operations in the cases reported above know nothing about these relapses. These cases happened to fall under the writer's care. As they came in close succession, they made a marked impression on him, and have been the cause of his change of technic, both in regard to original operations for hernia and also in recurrent cases.

We are convinced that our results are much improved. There will surely be less recurrences, both early and late, with linen sutures than with chromic gut or kangaroo tendon. And is it not to be expected that we will have much better results in recurrent cases if we use silver wire instead of catgut? There is a very pleasant feeling of security in doing an important herniotomy, to know that our linen knots (especially if three knots are made) will never open as the result of coughing or vomiting. With catgut we are never sure. The same thing applies to the early absorption of the knot. That is unknown with linen sutures and happens not so seldom with catgut, to the chagrin of the surgeon and the disgust of the patient.

As regards the recurrent cases, the writer is more and more convinced, with increasing experience, that some form of silver wire is, in many of the cases, a very desirable suture material. This is especially true of the cases in which either the muscle or Poupart's or both are poorly developed. We firmly believe that in such cases catgut is entirely out of place for the deep sutures. In some recurrent cases, where the tissues are well developed, linen will be very satisfactory, but in many of these recurrent cases, the best results will be obtained with silver wire.

We have no desire to be dogmatic, but, from what we have seen at the hands of other surgeons and from the cases reported above, we have in our hernia work come to the following conclusions:

1. Chromic catgut is an unreliable suture material.

2. Pagenstecher linen is an excellent suture material.

3. Silver wire, in some form, is a very desirable suture material in many recurrent cases; and at primary operations where the tissues are poorly developed

4. Immediate recurrence, in uninfected cases, is usually due to chromic gut.

5. We will have fewer recurrences if we entirely discard chromic gut sutures.

# A PNEUMATIC TOURNIQUET.*

BY FRANK E. BUNTS, M.D.,

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In Ashurst's International Encyclopedia of Surgery" may be found an interesting account of the introduction of the tourniquet, which I venture to reproduce, viz.:

> Next to the introduction of the ligature, the most important improvement in the operation of amputation was the invention of the tourniquet or "gripe-stick," as it was called by the English translator of Le Clerc. In its original form, this instrument, which was also known as the garrot or Spanish windlass, seems to have been devised about the same time (1674) by Morel, a French military surgeon, during the siege of Besançon, and by Young, of Plymouth, England, as described in his "Currus Triumphalis e terebintho," published in 1679. Morel's apparatus consisted of a thick compress, which was placed around the limb, and surrounded with a cord or small rope, under which were slipped two short sticks, by twisting which the cord was drawn very tight. Morel's tourniquet was improved by Le Dran and other surgeons by placing an additional pad immediately over the vessels and below the circular compress, by using only one stick for twisting the cord, and by placing beneath this a piece of paste-board—or, according to Garengeot, of horn or leather—so as to render the pressure on the skin less severe, and thus avoid the risk of sloughing, which sometimes followed the use of Morel's instrument. But the greatest improvement in the tourniquet was that made in 1718 by the illustrious J. L. Petit—le grand Petit, as he has been sometimes called to distinguish him from other less famous surgeons of the same name—and though, with its wooden plates and screw, we should think it but a rude contrivance, it was in all essential points the same instrument as the tourniquet employed at the present day.

Many other tourniquets have found their way into the armamentarium of the surgeon, such as Signoroni's, Lister's Cartes, Higgenbottom's, Tuffnell's, Skey's, and Esmarch's and their modifications. Some have had in view direct pressure upon the main artery of the limb but most have been, after all, but a slight improvement upon the garrot or Spanish

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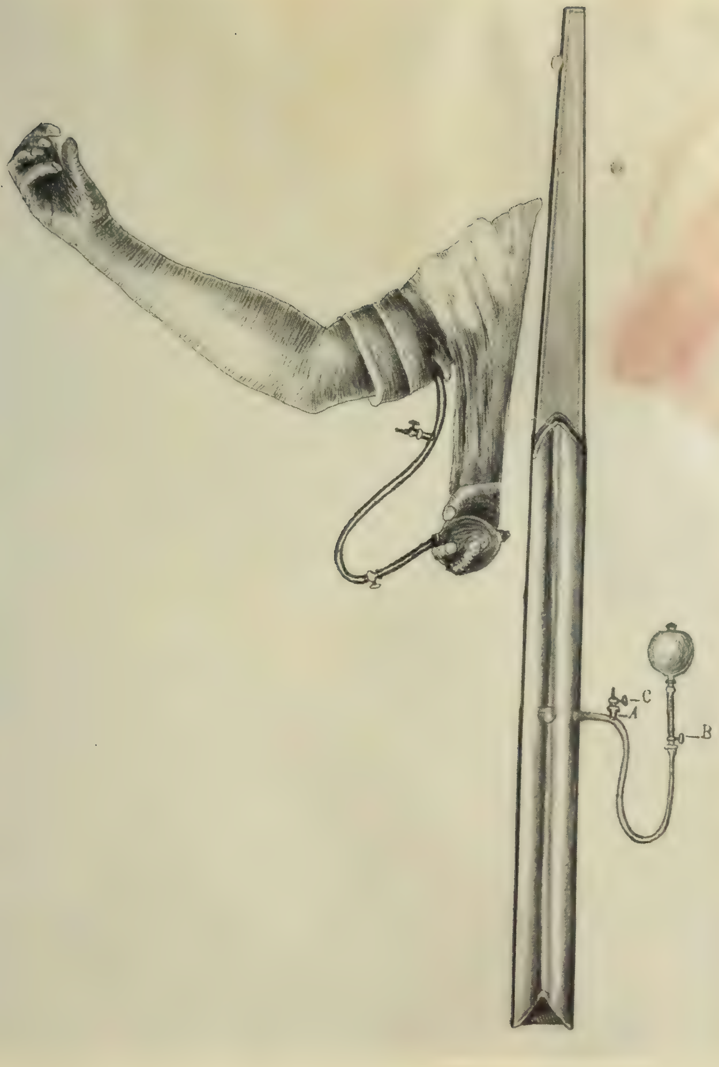
* Read in the Clinical and Pathological Section of the Cleveland Academy of Medicine, March 4, 1910.

FIG. 1.



The pneumatic tourniquet.

windlass. The one most commonly used is the Esmarch rubber band and chain or a simple rubber tube. These are certainly sufficient so far as controlling hemorrhage is concerned but are often so applied, either through ignorance, carelessness or perhaps unavoidably, as to cause very serious results, among which nerve palsy may particularly be mentioned. Thus when applied tightly above the elbow, musculospiral palsy may result and, if below the knee, peroneal nerve palsy sometimes follows.

In children particularly the need of some more suitable and more safely regulated pressure is manifest and, with this especially in view, I present for consideration a pneumatic tourniquet which, I think, will do away with some of the more obvious dangers of the older form of tourniquet.

In the *Medical News,* March 26, 1904, Dr. Harvey Cushing calls attention to a pneumatic tourniquet, which he had devised, based upon the well-known armlet of the Riva-Rocci blood-pressure apparatus and described as being a similar armlet though broader, of less distensible rubber and of such quality that it would stand boiling and, by connecting it with a bicycle pump of sufficient size, one or two quick strokes of the piston would fill it. This form of tourniquet has never become very popular, partly through lack of interest or information on the part of the profession, and partly because of the difficulty of keeping it from rolling when inflated and the necessity of a somewhat cumbersome apparatus (a bicycle pump) for its inflation.

I have devised an apparatus which is made of rubber and linen and consists virtually of two long rubber bags fastened together along their inner margins but connected at the middle by an opening through this fastening which permits the air to circulate simultaneously in both tubes when inflated. This obviates one of the greatest difficulties experienced in the construction of a practical pneumatic tourniquet. If it be made of a single rubber bag, the inflation will cause the superimposed turns of the tourniquet to roll off of each other and thus relieve the constriction. With the double tubes this cannot occur and it remains exactly where placed. The first one constructed for me was made of pure rubber and enclosed in a linen bag to prevent its overdistention but, as it was somewhat inconvenient to remove it and replace it in the bag for cleansing or sterilizing purposes, I have had the present one made of much the same material as the familiar obstetrical pad, which is sufficiently elastic, very strong and durable and can be readily sterilized. It has a tapering end which, after the tourniquet is in place, is tucked under the inflatable part and becomes fixed as soon as pressure is applied. From the middle of one of the bags projects a rubber tube with an offshoot, *A,* two stop-cocks, *B* and *C,* which permit respectively inflation by means of an attached bulb, and gradual diminution or total abolition of pressure by opening and allowing the escape of the air. If done slowly, undoubtedly venous engorgement would take place, but the inflature may be rapidly accomplished by a few pressures upon the bulb, and if still greater precaution against congestion is needed, the limb may be elevated or a Martin bandage applied before compressing with the tourniquet.

It can be applied uninflated to the limb prior to its preparation for operation and then, when needed, the circulation can be shut off by compression of the bulb without any disarrangement of the preparations about the field of operation. If, for any reason during the operation, it be desired to restore the circulation or to see whether the vessels have been secured, the air may be slowly allowed to escape by the anæsthetist or nurse by opening the stop-cock *C,* and controlled instantly by the re-inflation of the tourniquet, without having to readjust it. The advantage of this is apparent to any one who has been obliged to re-apply the ordinary tourniquet which has for any reason been removed when dressing the wound or at the close of an operation. The necessary disarrangement of towels and sheets and the pulling and jerking of the limb during this procedure are only too well known.

There are many practical applications of this tourniquet that suggest themselves, but it seems to me that one of the most beneficial would be its adoption by those engaged in the ambulance service or wherever it may require application by those not skilled in the use of tourniquets in general or not familiar with their dangers. Where the amount of visible hemorrhage is the only indication, certainly there could be no excuse for the viciously tight tourniquets and Spanish windlasses that we only too commonly see applied. A smaller one could be readily made which might be used for operations upon the scalp or skull, and it might find a most useful application in replacing some of the more cumbersome forms of armlets used in blood-pressure apparatus.

# THE CONTROL OF HEMORRHAGE BY MEANS OF FORCEPS-TOURNIQUET IN MAJOR AMPUTATIONS.

BY J. LYNN THOMAS, C.B., F.R.C.S.,

OF CARDIFF, ENGLAND,

Surgeon to the Cardiff Infirmary.

It was in an article published in *The Lancet*, 23d of April, 1898, that I first suggested the method of controlling hemorrhage at the hip-joint by means of a pair of forceps similar in general form to those of Doyen's stomach-clamp. Since that time I have performed all my major amputations after the same fashion, and have neither used the Esmarch's, nor any other form of tourniquet, nor have I availed myself of the services of a trained assistant to control hemorrhage in cases where great authorities like Lister, Macewen, Syme, and others have recommended them.

The pattern of forceps-tourniquet which I now use and find most convenient is illustrated in Fig. 1.

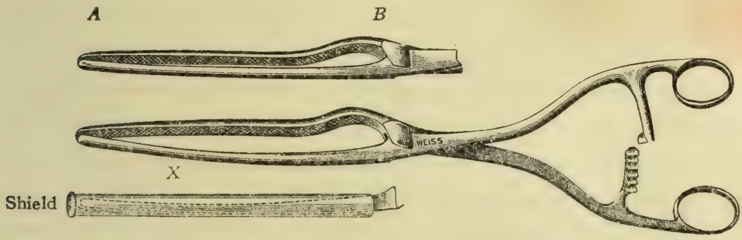
The blades of the forceps are 6½ inches long. For the purpose of description, I call the blade which is passed into the tissues, the *internal* blade; this is passed behind the blood-vessels and has a blunt point and is smooth and rounded in order to facilitate its passage through the tissues; at the same time to guard against the possibility of doing damage to blood-vessels or nerves against which it may impinge during its forcible passage.

I have found the ordinary Doyen clamp to be positively dangerous for the purpose, on account of the point and the edge of a blade being often as keen as that of a knife edge. The *external* blade (*i.e.*, the one in contact with skin) is rough and serrated in order to prevent it slipping over the surface of the skin. The *shoulder* is made on this blade in order to avoid compression of the skin and underlying tissues when the forceps is clamped on a muscular or fat limb, and also to prevent interference with the compression force of the far end of the forceps.

The principle of the method is that of simultaneous parallel compression of the blood-vessels (artery and vein) between the blades of the forceps; one blade (internal) being placed behind the blood-vessels to be controlled, and the other blade (external) being in contact with the skin.

In Fig. 2 is represented a transverse section through the hip-joint at a point where the internal blade of the forceps has been passed behind the blood-vessels and its external blade in contact with the skin.

Fig. 1.



*A–B*, 6½ inches (six and a half 'inches). *X*, smallest diameter of internal blade. 14b measured by Cicero Smith's micrometer. Shield for carrying antiseptic jelly for the internal blade during military operations.

I will describe the method as originally employed at the hip-joint. A small stab puncture was made immediately below the anterior superior spine of the ilium, and through this the *internal* probe-pointed blade was pushed forcibly towards the neck of the femur, parallel with Poupart's ligament, and driven home as far as it would go. The limb was then elevated vertically for a couple of minutes in order to exsanguinate it, then the forceps was clamped; this action effectually and simultaneously compressed the common femoral artery and vein. After the anterior flap was made and turned up, the gaping blood-vessels were clamped by hæmostatic forceps and afterwards the forceps-tourniquet was released and withdrawn and was then passed behind the neck of the femur in order to control the blood-vessels in the posterior flap.

By this method the loss of blood during amputations of the hip-joint has become practically negligible, and in quantity is not more than is always lost during amputation by any of the other so-called bloodless methods.

In 1904 I recorded a series of amputations which I had at that time performed successfully by this method of control of the main blood-vessels, and they included *three* at the hip, *five* interscapulothoracic, *seven* through the thigh, and others.

I then claimed that the mortality in amputations following this method of controlling hemorrhage was not more than that after any other method ever suggested. Since that time I have performed similar operations successfully, and in one case I have successfully removed the ilium in addition to the removal of the whole lower extremity.

The ages of my patients have ranged from infants to that of an old lady of eighty-four.

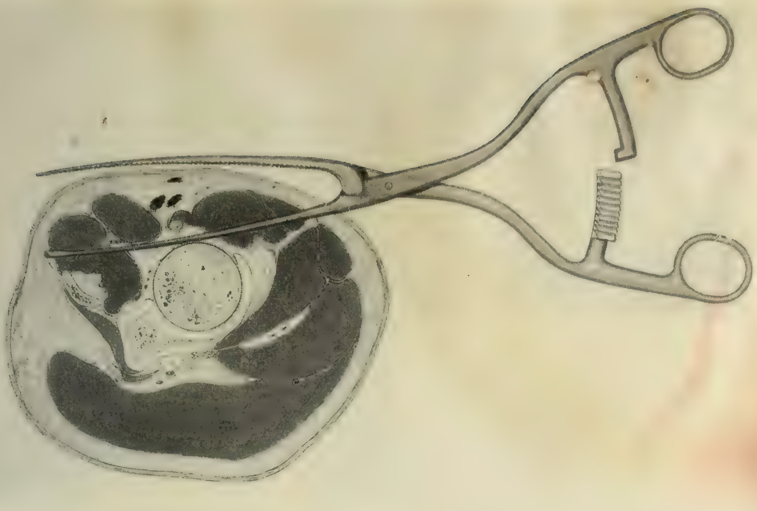
The method is simple, effective, reliable, and requires no assistant; the forceps-tourniquet is easily sterilized with the ordinary instruments, and during the operation it is entirely under the sole control of the operator.

It is not my intention to discuss the value of other methods of controlling hemorrhage, which are so well known to your readers, but I would invite my American confrères to give this method a trial, as I feel that it can be adopted without anxiety in the scrupulous requirements of modern aseptic or antiseptic surgery.

I believe that Dr. Charles Mayo was the first to use this method of controlling hemorrhage in the United States.

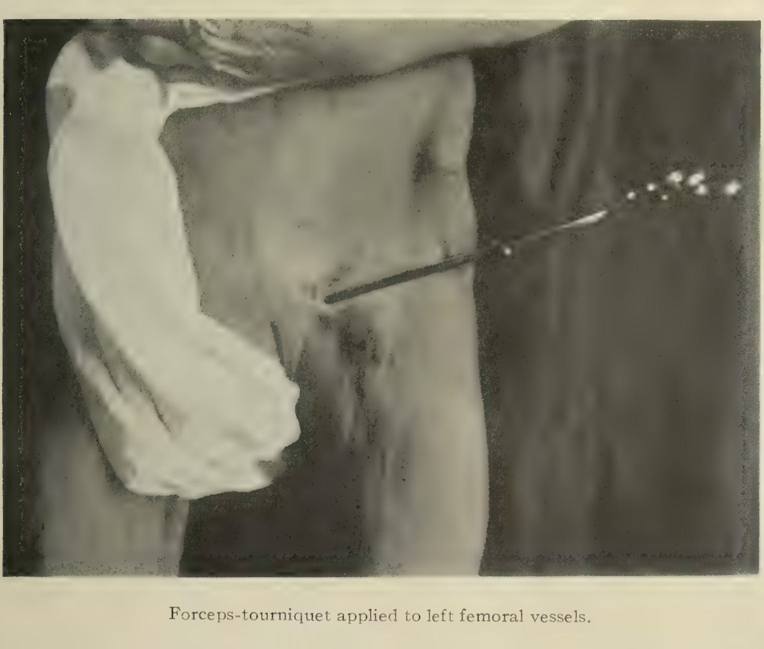
Note.—Since the above was written I am glad to find that Dr. Binnie in the second volume of his " Operative Surgery " refers to the method. Professor Kocher in Europe and Jacobson in England, and Thompson and Wiley in Scotland have already included in their well-known works my method amongst the recognized ones.

FIG. 2.



Section of thigh through hip-joint showing method of controlling femoral vessels by forceps-tourniquet.

FIG. 3.



Forceps-tourniquet applied to left femoral vessels.

# FIGURES ABOUT FRACTURES AND REFRACTURES OF THE PATELLA.

BY EDRED M. CORNER, M.C.,

OF LONDON,

Surgeon to Out-patients and the Surgical Isolation Wards; Lecturer on Practical
Surgery to St. Thomas's Hospital; Surgeon to the Children's
Hospital, Great Ormond Street.

THESE figures were compiled from the hospital annals for the purpose of a lecture.[1] As no similar figures have been adduced, it has been thought worthy to place them upon permanent record. The most important points which they show may be summarized as follows:

1. Fractures in the lower half of the patella are the most frequent, 83 per cent.
2. Triangular shaped patellæ are the most common; oblique shaped patellæ come next.
3. Transverse fractures are the most frequent; comminuted fractures come next.
4. Three males fracture their patella to one female.
5. Fractures of the right patella are a little more frequent than of the left.
6. Two underwent operation to every one which did not.
7. Fracture of the patella is most frequent between the ages of 30 to 40.
8. The patella is the most frequently refractured bone in the body.
9. After operation, 69 per cent. of refractures occur in the first year after the injury.
10. After treatment other than operation, 86 per cent. of refractures occur after the first year.
11. The percentage frequent of refractures is approximately the same after operative as it is after non-operative treatment.

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[1] Delivered at the Policlinic.

12. The advantages of operation are solely in the quick and complete recovery of the function of the limb.

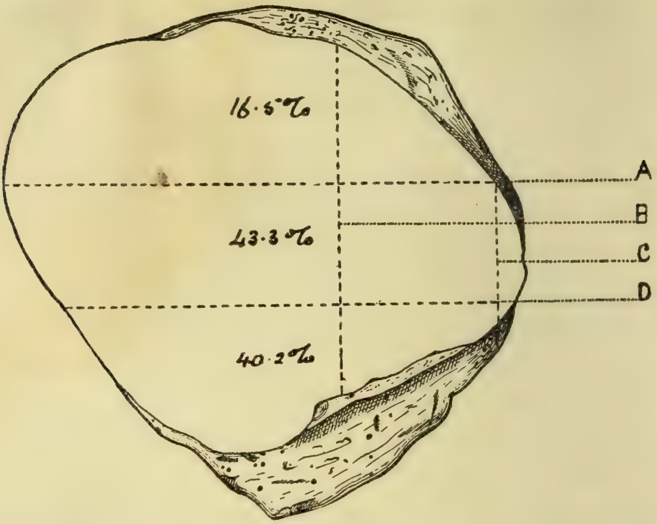

Diagram of the facets on the articular surface of the patella. *A* is the line marking the lower limit of the area in contact with the femur with full flexion of the knee. *D* is the line marking the upper limit of the area in contact with the femur in extension and slight flexion of the knee. *B* marks the division of the articular surface into right and left parts. *C* delimits the small area which is always in contact with the femur in all positions of the joint. The figures denote the percentages of fractures found in each area (see first table of figures).

## STATISTICS OF CASES OF FRACTURE OF THE PATELLA ADMITTED TO ST. THOMAS'S HOSPITAL, 1890–1907 INCLUSIVELY.

Total number of cases, 504.

| | | |
|---|---|---|
| Fracture in lower part of bone | 40.2 | per cent. |
| Fracture about centre of bone | 43.3 | per cent. |
| Fracture in upper part of bone | 16.5 | per cent. |
| Fractures in lower part of bone | 83.5 | per cent. |
| Triangular shaped patellæ | 66 | per cent.[2] |
| Oblique shaped patellæ | 20 | per cent. |
| Elliptical shaped patellæ | 9 | per cent. |
| Circular shaped patellæ | 5 | per cent. |
| Transverse fractures | 85 | per cent. |
| Oblique fractures | 4 | per cent. |
| Comminuted fractures | 10 | per cent. |
| Compound fractures | 1 | per cent. |

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[2] Proceeding of Anatomical Society, February, 1900, pp. xxvii and xxviii.

| | | |
|---|---|---|
| In male subjects | 73 | per cent. |
| In female subjects | 27 | per cent. |
| On right side | 55 | per cent. |
| On left side | 44 | per cent. |
| Bilateral | 1 | per cent. |
| Patella sutured | 65 | per cent. |
| Treated by splints and massage | 35 | per cent. |

| | |
|---|---|
| Earliest period of life in which fracture occurred | between 5–10 years. |
| Period at which fracture occurs most frequently | between 30–40 years. |
| Next period at which fracture occurs most frequently | between 40–50 years. |
| Latest period in which fracture occurred | between 70–80 years. |

### STATISTICS OF REFRACTURE OF THE PATELLA.

Total number of cases, 55.

| | | |
|---|---|---|
| Frequency of refracture | 11 | per cent. |
| Frequency of fracture of other patella | 1 | per cent. |
| Frequency of refracture after suture of the fragments | 10 | per cent. |
| Frequency of refracture after other treatment | 9 | per cent. |
| In male subjects | 84 | per cent. |
| In female subjects | 16 | per cent. |
| Of right patella | 56 | per cent. |
| Of left patella | 44 | per cent. |
| Bone twice fractured | 85 | per cent. |
| Bone three times fractured | 9 | per cent. |
| Bone four times fractured | 6 | per cent. |
| Compound refractures | 7 | per cent. |
| After suture, percentage of refractures within the first year | 69 | per cent. |
| After the first year | 31 | per cent. |
| After the first 3 years | 12 | per cent. |
| Within the first 3 years | 88 | per cent. |
| After other treatment, percentage of refractures within the first year | 14 | per cent. |
| After the first year | 86 | per cent. |
| Refracture occurring through the same place as the former fracture | 95 | per cent. |

Otherwise the refracture is above the line of the original fracture.

# TRANSACTIONS
OF THE
# NEW YORK ACADEMY OF SURGERY.

*Stated Meeting, held May* 11, 1910.

The President, DR. ELLSWORTH ELIOT, JR., in the Chair.

## THREE CONSECUTIVE TRANSFUSIONS FOR PROFOUND SECONDARY ANÆMIA.

DR. E. H. POOL presented a woman, 43 years old, who was admitted to the French Hospital on December 29, 1909. The following were the significant points of her history: Two weeks before admission she had suffered from violent headaches, pain in the back, and extreme weakness; a day later, slight jaundice appeared. She was confined to bed from the onset of her illness, growing steadily worse. For a number of years past she had at times suffered from a distressing cough and dyspnœa. Eighteen months ago she began to lose color, and this pallor had gradually become more pronounced. Menstruation had always been profuse, making her weak for some time following; the menorrhagia had been especially marked recently. She had two children, living and well; no miscarriages. Her habits were good.

Physical examination on admission: The patient was aroused with difficulty. Her mucous membranes were colorless, the lips dry, parched and brown; the conjunctivæ were slightly yellow; the skin had a lemon tint and was bloodless. The radial pulse was imperceptible and the heart sounds were very feeble. The woman appeared to be moribund. A blood examination showed 600,000 red blood-cells and 16 per cent. hæmoglobin. The urine contained a trace of albumin, abundant red blood-cells, a few leucocytes and hyaline and granular casts.

Transfusion by the Carrel suture method was immediately done, taking the woman's husband as donor, although he was weak and anæmic, his hæmoglobin being 70 per cent. Following this there was some improvement in her condition, but the hæmoglobin rose only to 22 per cent. Blood examination that evening and on several subsequent occasions suggested pernicious anæmia.

The next day a second transfusion was made, taking a young man as donor. This was followed by marked improvement. The patient's cheeks became flushed, and her lips resumed a normal color. She, however, became extremely restless, and it was necessary to stop. During this transfusion, the patient's hæmoglobin rose to 33 per cent., and the number of red cells to 2,000,000. Afterwards she became delirious and two days later showed extreme jaundice.

Ten days later a third transfusion was done, as the patient's blood and general condition showed a marked tendency to become worse. A healthy young man was taken as the donor. Considerable and prolonged improvement followed this operation, the hæmoglobin rising from 23 per cent. to 56 per cent. during the transfusion.

After the third transfusion, the patient's blood continued to improve, although she developed a pneumonia in the right lower lobe, and subsequently pleurisy with effusion on the left side. Dr. N. B. Potter took charge of the patient during this illness, and made sixteen aspirations, removing from 20 to 30 ounces of clear or blood-tinged fluid each time.

The patient was now in good health, with 70 per cent. of hæmoglobin and over 3,000,000 red blood-cells. The blood examination was otherwise negative; the urine contained a trace of albumin.

According to Dr. Potter and Dr. F. C. Wood, the blood picture was not one of typical pernicious anæmia, but rather of very marked secondary anæmia, with a persistently high color index.

## CARCINOMA OF AN ACCESSORY THYROID.

Dr. Pool presented a woman, 46 years old, who was admitted to the service of Dr. Frank Hartley, at the New York Hospital, on April 8, 1910. Three years ago she first noticed a small lump on the left side of the neck which had gradually increased in size. It was never painful. Last summer she began to have stinging pains of great severity in the left shoulder, and recently these pains had extended to the left arm. They had gradually been growing more severe, and three days before admission she began to have constant pains of the same character in her left hand and wrist. She had lost about thirty pounds in weight in the past year.

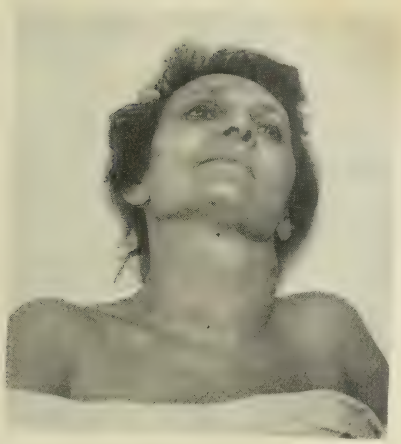
Physical examination: The patient was a well-developed woman. She complained of slight stiffness and pain on moving the neck. On the left side, corresponding approximately to the lower two-thirds of the sternomastoid muscle, there was a swelling about three and a half inches in diameter. The skin covering this was movable and normal in appearance. The swelling, which lay in part beneath the sternomastoid muscle, was hard, slightly nodular, and somewhat movable, but did not move during deglutition (Fig. 1). The pulsation of a large vessel could be felt mesial to its upper limit. In the left arm, the grip was relatively weak, but there was no paralysis nor anæsthesia. Eyes, respiration, voice and deglutition were normal.

Operation, by Dr. Frank Hartley: The mass was exposed by an incision along the anterior margin of the sternomastoid. The internal jugular crossed it vertically, and was ligated above and below; the omohyoid also crossed it, and was cut. The mass was then readily enucleated, after ligating several large nutrient vessels. The carotid lay posterior to the growth, the sternohyoid and sternothyroid mesial. On lifting these, the whole of an apparently normal thyroid gland, with isthmus and pyramidal lobe, was exposed. The patient made an uneventful operative recovery.

Report of specimen, made by Dr. Elser, Pathologist to the New York Hospital. The specimen consisted of an aberrant thyroid gland, oval in shape, measuring 9.5 cm. in length, 5.5 cm. in breadth and 5 cm. in thickness. The mass was covered on the outside by filmy connective-tissue membrane, through which numerous large, vascular channels were dispersed. Projecting beneath this capsule were many irregularly outlined, yellowish nodules. The mass was quite firm in consistence. On section, the cut surface was diffusely brownish-yellow in color, and irregularly lobulated. At one pole of the mass was a large area of necrosis. The specimen was accompanied by half a dozen enlarged lymph-nodes; most of these were yellowish-brown in color and were surrounded on the outside by connective-tissue capsules. On section, the cut surface was moderately granular, yellowish in color and elastic in consistence.

Microscopical examination of the accessory thyroid revealed the typical histology and papillary adenocarcinoma. Microscopical examination of the lymph-nodes revealed extensive metastatic deposits. Practically all the lymphoid tissue had been replaced by tumor growth.

FIG. I.



Carcinoma of accessory thyroid.

## PARTIAL THYROIDECTOMY FOR EXOPHTHALMIC GOITRE.

Dr. Willy Meyer presented a man, 36 years old, who came to the German Hospital early in 1910 with all the signs of typical exophthalmic goitre, and gave a history which dated back five years. During the past eighteen months his symptoms had become more pronounced; there was dizziness, rapid pulse and marked exophthalmus. He was first treated with the serum prepared by Merck, antithyroidin, in comparatively large doses. A week or ten days later the entire thyroid gland was exposed through a transverse incision, with the intention of removing the right lobe. There was still profuse hemorrhage after the right thyroid arteries had been tied; this was immediately checked after crushing and ligation of the isthmus, which was much enlarged. About one-third of the gland was left.

The patient made a rapid recovery, and a few weeks after the operation it was found that his pulse had materially improved, the exophthalmus was less pronounced and his other symptoms had disappeared. His highest temperature following the operation was 102.8, and this rapidly subsided.

## CASES ILLUSTRATING THE EFFECT OF ARTIFICIAL ARTERIAL HYPERÆMIA IN THREATENING GANGRENE OF THE FOOT, DUE TO DIABETIC ENDARTERITIS.

Dr. Willy Meyer showed these cases. The first patient was a man, 60 years old, diabetic, on whom he did an amputation of the thigh in January, 1907, for dry, rapidly spreading gangrene of the toes and foot. The operation was done under spinal anæsthesia, and with secondary suture of the wound.

About a year and a half later this patient began to show evidences of beginning gangrene of the opposite foot; several toes became affected, and as the man absolutely refused further operative interference, it was decided to try artificial arterial hyperæmia. A suitable hot air apparatus was thereupon provided, and under this method of treatment, which had been faithfully carried out since, the gangrenous process affecting his remaining foot had been overcome. Not one part of the toes necrosed. Two apparatuses were used, alternatingly daily, one for the thigh and leg with high temperatures, the other for the affected foot with lower temperatures, inasmuch as the affected part cannot stand great heat.

Dr. Meyer's second patient was a man, also 60 years old. The case was one of beginning diabetic gangrene involving the toes of both feet, with some œdema and threatening pains that indicated an extension of the process. A properly fitting hot air apparatus was provided, in which the upper and lower portions of the extremities were alternately exposed to a very high temperature. The result of this treatment was beyond expectations. The threatening gangrene failed to extend, the bluish discoloration of the toes disappeared, the patient had remained in comparatively good health and was able to go about without the aid of a stick or other support. He had now been using this apparatus daily for the past seven months, and the treatment was still being faithfully carried out.

As a matter of fact, this treatment will be successful in a certain number of cases only. Still it means an addition to our therapeutic resources, and deserves further trial. It is not indicated in the moist form of gangrene.

He had tried it also in two cases of Raynaud's disease. In one it had a temporary effect only, in the other none at all.

Dr. Howard Lilienthal said that the results of the hot-air treatment in these cases were certainly wonderful, and personally he had never seen anything like it. He inquired whether in the last case shown there was any pulsation in the posterior tibial, and also how long these patients continued the exposure to the hot air at each session. Also, what sort of apparatus he had been using, and how long he would advise the continuance of the treatment? The first case was apparently one of thrombo-angitis obliterans, in which the speaker said he had always advised amputation, whether the gangrene was of the dry form or not.

Dr. Meyer said that both the patients were diabetics. The hot-air exposures were at first limited to a fraction of one hour at each sitting, but the time was gradually lengthened to a whole hour daily. For the purpose of heating the apparatus, electricity was much superior to the Bunsen burner, as with the former there was no odor and there was no danger of fire or explosion. He warned against the use of alcohol as a means of heating the apparatus, and he recalled one case at the German Hospital where the alcohol lamp had set fire to the blankets covering the leg.

The treatment should be continued by the patients themselves—perhaps with longer or shorter intermissions—as long as they lived.

## THE FIRST CASE OF THORACOTOMY IN A HUMAN BEING UNDER ANÆSTHESIA BY INTRATRACHEAL INSUFFLATION.

Dr. Howard Lilienthal presented this patient, with full description of his condition, for which see Annals of Surgery for July, page 30.

## CLINICAL EXPERIENCE WITH INTRATRACHEAL INSUFFLATION (MELTZER), WITH REMARKS UPON THE VALUE OF THE METHOD FOR THORACIC SURGERY.

Dr. Charles A. Elsberg read a paper with the above title, for which see Annals of Surgery for July, page 23.

Dr. Willy Meyer said that he was firmly convinced that in the course of time we would not depend on any single method in the performance of intrathoracic operations, and if this apparatus for intratracheal insufflation, which was less expensive than the differential pressure cabinets, was shown to work as well in human beings as in animals, we could look forward to its more general employment with much satisfaction as an addition to our mechanical resources in thoracic operations. The differential pressure cabinet and chamber had its field of usefulness in the large hospitals, where no doubt intrathoracic surgery would soon be undertaken by many surgeons.

Dr. Meyer said he had several times occasion to go deeply into the literature of thoracic surgery, and he had found that in 1896 Professor Tuffier, of Paris, had introduced a metal tube through the larynx deep into the trachea for anæsthesia, compressed the trachea above with a special clamp, and in this manner succeeded in narcotizing a patient and successfully doing a resection of the lung. This seemed to be the first case of intratracheal anæsthesia in the human. It was surprising that Tuffier did not continue his successful experiments. Two years later, Dr. Parham, of New Orleans, an associate of Dr. Matas, did a resection of the chest wall for the removal of a malignant growth. To anæsthetize the patient, he employed a Fell-O'Dwyer tube of a special conformation and just long enough to dip into the trachea. By this means he successfully removed the growth. Here also intratracheal anæsthesia was helpful in completing the operation.

Regarding the patient presented by Dr. Lilienthal, he suggested that some artificial pneumothorax was left unintentionally when closing the thorax. The air in the pleural cavity first compressed the lung and reduced the size of the abscess cavity or cavities. With increasing absorption and attenuation of the component gases of the air the cavities again distended and the cough with expectoration returned.

Dr. S. J. Meltzer said that in his earlier experiments with the intratracheal insufflation method the pressure of the air current before entering the trachea was, as Dr. Elsberg had pointed out, limited to a variation from ten to twenty mm. of mercury, but his more recent investigations had shown that the degree of this pressure had very little significance so long as the intratracheal tube was not too large to permit the free return of air. For example, it was found that an external pressure of 25 mm. produced in the trachea and bronchi a pressure of only 5 mm., and that a sudden increase of the external pressure to 50 mm. raised the pressures of the bronchi and trachea only 1 mm. of mercury.

This method of intratracheal insufflation, Dr. Meltzer said, was now being experimented with as a means of saving life in strychnine poisoning. In control experiments it was established that four-tenths of a milligramme of strychnine given to a dog by intravenous injection resulted fatally within 45 minutes. Eighteen dogs, which received eight-tenths of a milligramme of strychnine by intravenous injection, that is, twice the fatal dose, were kept alive and completely recovered by the aid of the intratracheal insufflation, which was kept up continuously in some cases as long as eight or nine hours. The convulsive movements were controlled by curarin and injections of Ringer solution were given to hasten the elimination of the strychnine by the kidneys. At the subsequent autopsies of these animals, there was not the slightest evidence of an injury to the trachea or lungs.

Dr. N. W. Green thought that Dr. Meltzer deserved especial credit for developing this method of intratracheal insufflation for intrathoracic work, for which so many other similar methods had been ineffectually tried. In this connection, it may be interesting to note that a case was reported by Chaussier in 1781, in which he used an intralaryngeal canula to resuscitate a young man said to have been in the last stages of phthisis. This case was reported before the Royal Society of Medicine, Paris.

Dr. Lilienthal said that in the case of thoracotomy he had reported, while there were quite a number of adhesions between the visceral and parietal pleuræ, these did not impede the motions of the lungs to the slightest degree. He had made no attempt to loosen these adhesions. The lung was blown up to its fullest capacity before closing the chest, and the wound was then covered with moistened gauze.

Dr. Elsberg, in closing the discussion, emphasized the fact that the method of Dr. Meltzer differed absolutely in principle from that of the previous intratracheal methods. All of the methods that had been formerly advocated consisted essentially of the introduction of a tube into the trachea, which closed about the tube. By Dr. Meltzer's method, the tube was introduced almost down to the bifurcation, and it was so small that it permitted the free escape of air. With this method, it made no difference whether the patient breathed or not, whereas with the positive or negative cabinet it was very essential that the patient should not stop breathing.

# BOOK REVIEWS.

Diseases of the Stomach and Intestines. By Robert Coleman Kemp, M.D., Professor of Gastro-intestinal Diseases in the New York School of Clinical Medicine. 8vo, pages 710, illustrations 280. W. B. Saunders Company, Philadelphia and London, 1910.

The study of gastro-intestinal diseases is at the present date in an active transitional state. This is due mainly to the fact that in some instances, lamentably few we must confess, the clinician is confirming his diagnosis through means of the surgeon and the living pathology of the operating table. This is much more important in its results, both immediate and remote, as far as the welfare of the patient is concerned, than that information which we have hitherto acquired through the agency of the post-mortem.

What, then, have been the results? The answer is short, but yet revolutionary in its significance. Briefly it indicates that chapter after chapter of books which we have heretofore accepted as standard must be so altered and revised that the identity of the old ones will be completely lost. The treatise on diseases of the stomach in the future will decrease rather than increase in volume. What is needed and what will be produced is a work on *practical gastro-enterology*.

Can the general practitioner, or indeed the stomach specialist, be made to appreciate that in a thousand consecutive cases applying to him for relief of gastric symptoms, in less than 10 per cent. will the trouble be found in the stomach? In the other nine hundred cases he must look for, identify, and treat the etiologic factor, he must minister to the house that is burning, and not to the central station from which the alarm was sent out.

The author prefaces the present volume by remarking that in view of the excellent works on diseases of the stomach and intestines already placed before the profession, a new book on these subjects might seem superfluous. In considering the above facts and the large experience of the author, such a conclusion,

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In general, the author has brought up to date the knowledge of the subject as prescribed by the field indicated in the title, and as a record of personal experience and contemporary achievement will form an addition to our appreciation of the realms of gastroenterology.

FRACTURES AND DISLOCATIONS. By LEWIS A. STIMSON, B.A., M.D., Professor of Surgery in Cornell University Medical College, New York. Sixth edition, thoroughly revised. Octavo, 876 pages, with 361 engravings and 65 plates. Lea and Febiger, Philadelphia and New York, 1910.

This treatise, which is now in its sixth edition, has been repeatedly reviewed in the ANNALS OF SURGERY, and it is not necessary to mention again the character of the work. The present edition is encyclopædic in its scope as far as fractures and dislocations are concerned, and cosmopolitan in the knowledge presented, owing to the inclusion of the accepted views of specialists throughout the world.

In this edition the author has enlarged our knowledge principally as regards the injuries of the small bones of the carpus and tarsus, and includes a new subhead, "The Midcarpal Frac-

[illegible] the recognition of which has come mainly [illegible] gatio[illegible] stimulated and aided by X-ray examinat[illegible] also been added on fractures of the floor o[illegible] and of the internal epicondyle of the femur, a[illegible] ward dislocation of the lower jaw. Other additions [illegible] ance relate to treatment. Under this subject we find [illegible] nce made to the employment of metal plates for the correction of deformities in the long bones, as advocated by Lane.

Although the medical practitioner is loath to assume the responsibility of a complicated fracture, those who are situated far from the great centres must assume this responsibility, however limited may be their experience. To these men this book especially appeals as being a most complete, conscientious, and satisfactory treatise.

James T. Pilcher.

## CORRESPONDENCE.

### ALBA'S OPERATION.

In the report of the proceedings of the New York Surgical Society in the Annals of Surgery, vol. lii, No. 6, pages 938, 939, in describing the operation for rheumatoid arthritis of the hip the text calls it "Abbe's operation." It should be Alba's (Dr. F. H. Alba).

H. M. Lyle.

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ANNALS OF SURGERY

VOL. LII DECEMBER, 1910 No. 6

# ORIGINAL MEMOIRS.

## THE TREATMENT OF SCALPING ACCIDENTS.*

### REPORT OF TWO CASES OF SCALPING BY MACHINERY, WITH A CONSIDERATION OF SCALPING ACCIDENTS IN GENERAL.

BY JOHN STAIGE DAVIS, M.D.

OF BALTIMORE, MD.,

Instructor in Surgery, Johns Hopkins University; Assistant Surgeon Out-Patient Department, Johns Hopkins Hospital.

IN text-books and systems of surgery scalping is generally considered under "Lacerated Wounds of the Scalp," but it is undoubtedly a lesion whose treatment requires much more careful study and attention than is usually accorded it.

This paper is based upon a critical review of the literature, my own experimental work, and on two cases of complete scalping, which were healed by skin transplantation. On one of these cases, that of Dr. Bloodgood's, Thiersch grafts only were used, while on the other, which was my own, the healing was brought about entirely by whole thickness grafts.

I take this opportunity of thanking Dr. Halsted for the use of the cases from his clinic, reported in this paper, and also Drs. Cone, Porter, Roberts, and Spencer for allowing me to include in my series their unpublished cases of complete scalping.

### REPORT OF TWO UNPUBLISHED CASES.

CASE I (Dr. J. C. Bloodgood).—Admitted to the Church Home and Infirmary on August 24, 1906. Diagnosis: complete scalping by machinery. Treatment: grafting with Thiersch grafts. Result: recovery.

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* The full text of this paper with detailed case reports, bibliography, etc., will appear in vol. xvi of the Johns Hopkins Hospital Reports.

*Clinical History.*—White, female, aged 41 years, operator in a canning factory.

*Family and Personal History.*—Unimportant.

*Physical Examination.*—This was negative, except as noted below.

*Present Illness.*—On August 21, 1906, the patient caught her hair on a rapidly revolving shaft, which was directly over her head, and was completely scalped. The line of tearing included both eyebrows and extended backwards, just above the ears, to below the hair line on the neck. There was some laceration of the right ear and several periosteal defects, but no other injury. There was no loss of consciousness, but the pain was very severe. The hemorrhage was marked. No attempt was made to replace the scalp.

On admission to the hospital the patient was in a fairly good physical condition. Red blood-corpuscles 4,400,000, hæmoglobin 80 per cent. She was suffering considerable pain. The head was dressed with wet salt solution dressings, and the eyes were irrigated with boric solution.

September 13, 1906: The growth of the granulations was exceedingly slow, but in spite of this it was decided to graft. Large Thiersch grafts, obtained from a young woman, 19 years old, were applied by Dr. Follis. The result was total failure, which was probably due to the unsatisfactory condition of the granulation tissue.

By the use of the following technic good healthy granulations were produced. A single layer of dry gauze was placed over the wound, and this was covered with rubber protective. This dressing was changed every other day. The granulations were stimulated by the gauze and were held flat by means of the protective. In about two months the granulations were in excellent condition and there was a growth of epithelium one-fourth of an inch wide around the edges of the wound.

November 15, 1906: Operation, Dr. Bloodgood, assisted by Dr. Follis; ether anæsthesia. The entire granulating surface was swabbed with pure carbolic acid followed by alcohol. The left half of the wound was freely scarified with a knife and, after the hemorrhage was checked, was covered with large autodermic Thiersch grafts. The grafts were dressed with silver foil, over which was placed collodion and little strips of gauze, then more collodion, silver foil, and more gauze. The ungrafted portion of the head was covered with boric ointment, collodion, foil, and gauze, completing the cap, which was held snug by straps of adhesive plaster. Practically all of these grafts were successful.

December 6, 1906: The right half of the head was prepared, grafted, and dressed in a similar manner, with equally good results. The grafts were cut by the modified Thiersch method used at the Johns Hopkins Hospital.

Ulcerations appeared here and there on the grafted area, but these soon healed. The patient was discharged on March 8, 1907, with the newly grafted area in excellent condition (Fig. 1).

*Examination of the Patient on March* 17, 1910.—The head was covered with a smooth, thin, shiny, movable skin, in which could be seen numerous blood-vessels. On the vertex were five or six small ulcerations, the largest being about the size of a ten-cent piece. These ulcers were sometimes painful. She said that small ulcerations had occurred from time to time ever since leaving the hospital.

There was normal sensation over practically the entire grafted area. There was no retraction of the eyebrows and the eyelids could be closed normally. The patient was continually bothered by the sensation of a heavy weight pressing on the top of her head, and she said that she could not lean over without a feeling of great tightness in the same area.

CASE II.—The case described below was referred to me for treatment through Dr. J. M. T. Finney. The history before the patient came under my care was obtained partly from the family physician, Dr. A. H. Montgomery, of Montgomery, Alabama, and partly from the patient herself.

On July 29, 1907, Miss X caught her hair on a rapidly revolving shaft under which she had inadvertently walked. The shaft was above her and on her left side. She was lifted up and when the scalp gave way she fell back to the floor. There was little immediate pain but the hemorrhage was profuse, although of short duration. There was no loss of consciousness. She did not realize that the scalp was gone until she put her hand to her head.

Examination showed that the scalp had been torn off from the hair line in front to the hair line behind, including the entire occipitofrontalis muscle, and the line of tearing extended from immediately above the right ear to below and including the left ear, and also an area of skin on the cheek below and in front of it. The skin of the forehead was hanging down over the eyes. This was sutured to the periosteum and the wound cleaned as well as possible. Three bleeding points were tied. There was a defect in the periosteum in the left frontoparietal region. No other injury was found. No attempt was made to replace the scalp. The head was dressed with rubber tissue and sterile gauze.

There was very little pain on the night of the accident, but on the day following and continuing for two weeks the suffering caused by the dressings was very severe. The pain was localized in two spots just below the superior curved line of the occipital bone about one inch from the middle line on each side, and there was also a sensation of strong pulling.

Six weeks later skin was taken from her thighs after the method of Thiersch and was placed on the front part of the wound, on the lobe of the left ear and on the triangular space below it. The result of this grafting was not satisfactory. No further grafting was attempted until the following year.

On August 13, 1908, after careful preparation, Thiersch grafts from a lamb were applied. In September strips of whole thickness lamb skin were transplanted. About one month later guinea-pig skin was used, and two months later lamb skin was again tried. All of the grafts were placed on the periosteum following the removal of the granulations, and all were unsuccessful.

The patient came under my care on May 1, 1909, and was admitted to the Union Protestant Infirmary on that date.

Diagnosis: granulating wound following complete scalping by machinery. Treatment: grafting with whole thickness sessile skin flaps. Result: recovery.

*Clinical History.*—White, female, aged 24 years, milliner.

*Personal and Family History.*—Unimportant.

*Physical Examination.*—This was negative, except as noted below.

When the dressing was removed a mass of fungating gelatinous granulations, which bled easily, was exposed. These were very exuberant and the entire mass could be moved by resting the hand on the vertex and gently making excursions from side to side. This area measured in the middle line from front to back 23 cm., and from ear to ear 28 cm. It was surrounded by a cicatrizing border about 1 cm. in width. The left ear was lacking except for a small part of the lobe. The outline of the ulcer can be well made out in Fig. 2, taken three weeks after admission.

May 1 to May 28: The wound was thoroughly cleaned. The patient was put on forced feeding and tonics, and also was required to live and sleep out of doors, in order to secure the best physical condition.

Within a short time, following the free use of nitrate of silver stick and tincture of iodine, the character of the granulations decidedly changed. After these applications the patient was placed in the sunshine, which was allowed to fall directly on the granulating area. The time of this exposure varied from half an hour at first to the entire day. After the exposure the wound was dressed with balsam of Peru, 2 parts, and castor oil, 6 parts, on an adjustable cap (Figs. 3 and 4).[1] There was no pain whatever connected with these dressings.

I decided to use only whole thickness grafts in order to get a more lasting, durable healing.

June 3: Whole thickness grafts 20 x 4.5 cm. were removed from each thigh, after blocking the external cutaneous nerves.

June 15: Whole thickness grafts 16 cm. long by 7 cm. wide were taken from both sides of the lax abdominal skin, under local anæsthesia with Schleich's solution. All of these flaps were removed with the subcutaneous fat, and dry technic was carefully observed throughout. The fat was removed and the flaps were freely button-holed and placed on undisturbed granulations. Over the grafts, and overlapping the healthy skin and uncovered granulating areas, rubber impregnated mesh was placed. The ends were twisted and secured by adhesive plaster. The grafts were dressed with normal salt solution for 48 hours. The mesh was kept in place for about one week. All of these grafts were successful (Fig. 5).

June 24: Several large pieces of whole thickness skin, obtained from a ventral hernia case, were applied six hours after removal. This skin had been chemically cleansed and a large part of it was scar tissue. It was treated and dressed in the usual manner. These grafts seemed to take throughout, but later a considerable portion sloughed.

June 30: Whole thickness grafts 22 x 5 cm. and 20 x 4.5 cm.

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[1] This cap was devised by Miss E. Bowman, the nurse in charge of the patient at the Union Protestant Infirmary.

were obtained from the thighs under local anæsthesia, and were treated as usual. These were successful. All the grafts were exposed to the air after the first 48 hours, and were anointed with either Porter's ointment[2] to prevent drying out or with scarlet red 8 per cent. along the margins.

During the next two months a number of small superficial ulcers appeared in the cicatrix which formed before grafting was commenced, and a number of granulating areas were left by the sloughing of the isodermic grafts.

August 30: Under nitrous oxide anæsthesia whole thickness flaps from both legs, 20 x 4.5 cm., and from the abdomen, 15 x 4 cm., were removed and treated in the usual manner. It was necessary to divide the flaps in order to fit them into the irregular shaped areas. Practically all of these grafts were successful.

September 25: Several resistant ulcers appeared in the marginal cicatrix, and these were successfully grafted with small deep grafts, which were dressed with narrow overlapping strips of rubber protective.

October 8: Similar grafts were placed on three small areas where one of the thick grafts had been very slow in "topping off."

October 23: Another small ulcer in the cicatricial tissue was grafted with small deep grafts. All of these grafts were successful.

When discharged, November 16, 1909, the scalp presented the following appearance: The denuded area was entirely healed (Fig. 6). The greater part was covered with stable whole thickness skin, which was normal in appearance and was soft and movable. Acute sensation was practically confined to the cicatricial border around the grafted area. There was definite growth of fine hair on those grafts which were obtained from the thighs and legs, showing that the skin with all that belonged to it was transplanted.

The general condition of the patient was excellent, and with the aid of a wig a good cosmetic result was obtained (Fig. 7).

A comparison of these two cases is interesting. Both were females, aged respectively twenty-two and forty-one

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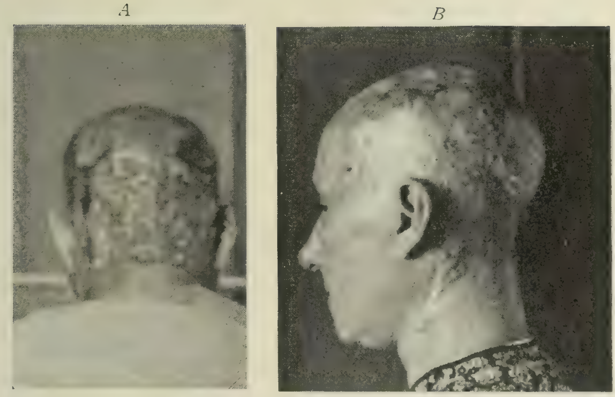
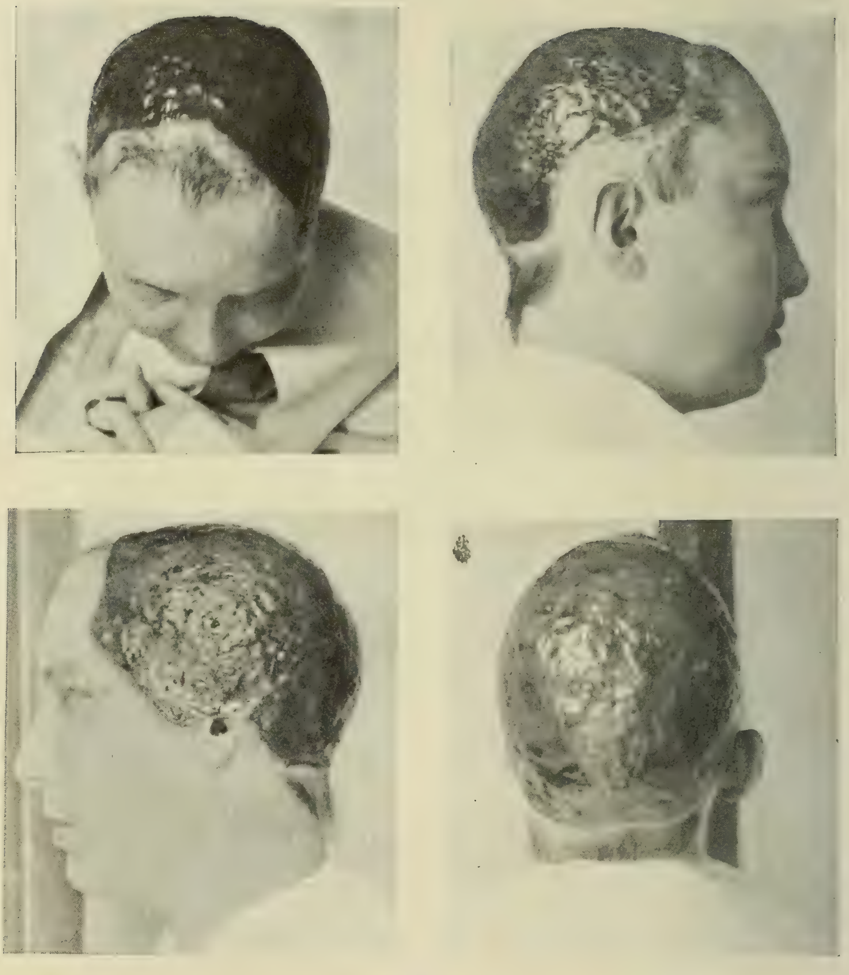
[2] Porter's ointment: citrate of silver 1 part; ichthyol, 4 parts; benzoinated lard, 175 parts; lanolin, 25 parts (ANN. OF SURG., November, 1907, p. 660).

FIG. 1.



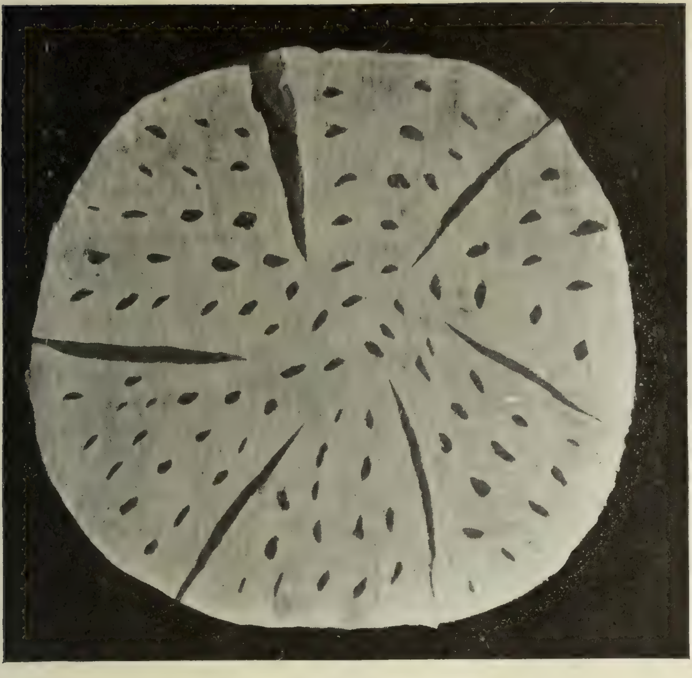
*A*, before grafting; *B*, result of grafting with Thiersch grafts (Bloodgood's case).

Fig. 2.



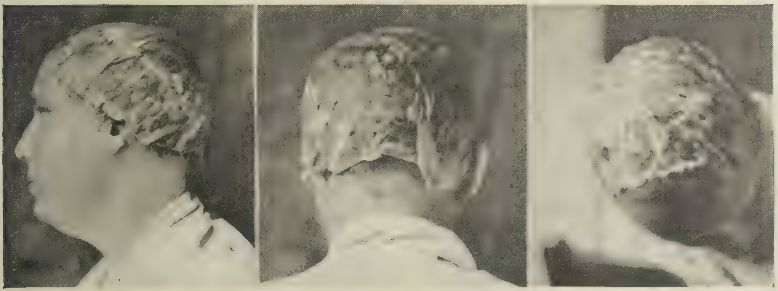
The denuded area three weeks after admission to the Union Protestant Infirmary. The granulations are clean, healthy, and nearly ready for grafting. The narrow zone of cicatrization can be seen, which shows the extent of the healing from the edges since the accident occurred 22 months before, and emphasizes the slowness of healing by cicatrization. Case II.

FIG. 3.



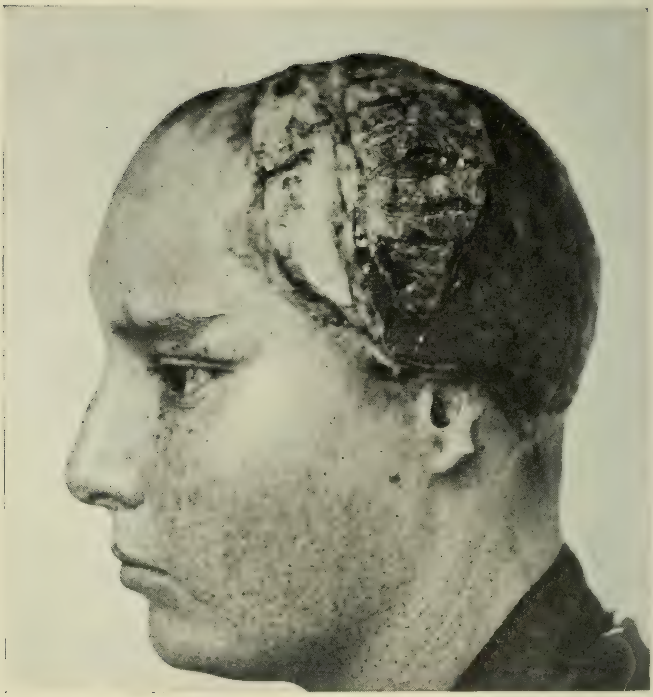
Adjustable cap made of old linen which is button-holed to allow the escape of secretions. The diameter is 12 inches. The cap can be saturated with oily dressings, or ointments may be spread on it.

FIG. 4.



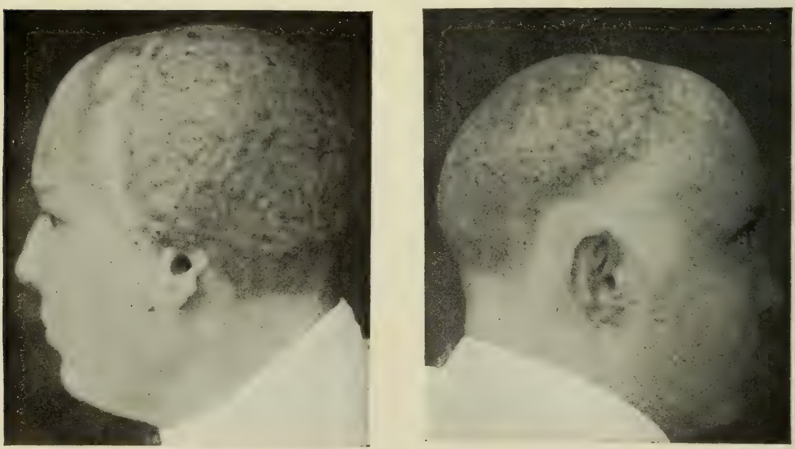
The adjustable cap shown in Fig. 3 in position. The use of this cap simplifies the dressing of the rounded granulating surface.

FIG. 5.



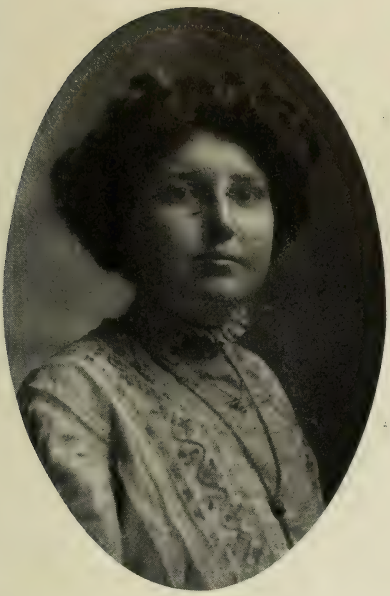
A portion of the first and second graftings. The first graft, which is in front, has nearly assumed the level of the normal skin, while the one behind it is still considerably thickened. The large button-holes in the second graft can be plainly seen. Case II.

FIG. 6.



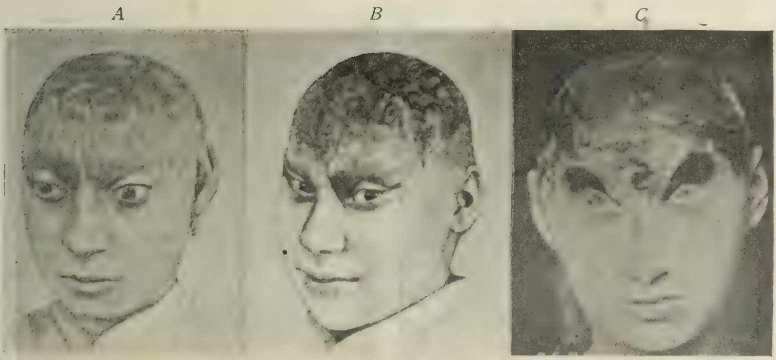
Side views, completely healed by whole thickness grafts. Case II.

Fig. 7.



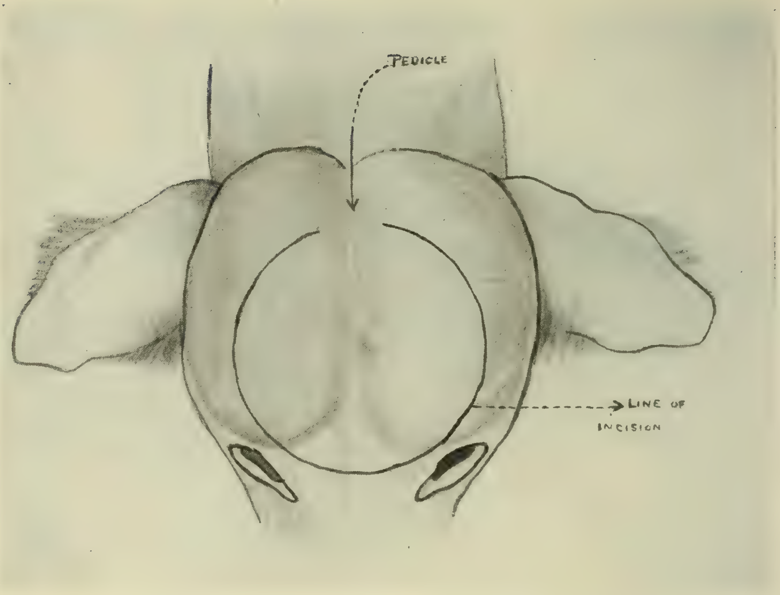
Patient with wig on. Photograph taken one month after leaving hospital. Case II.

Fig. 8.



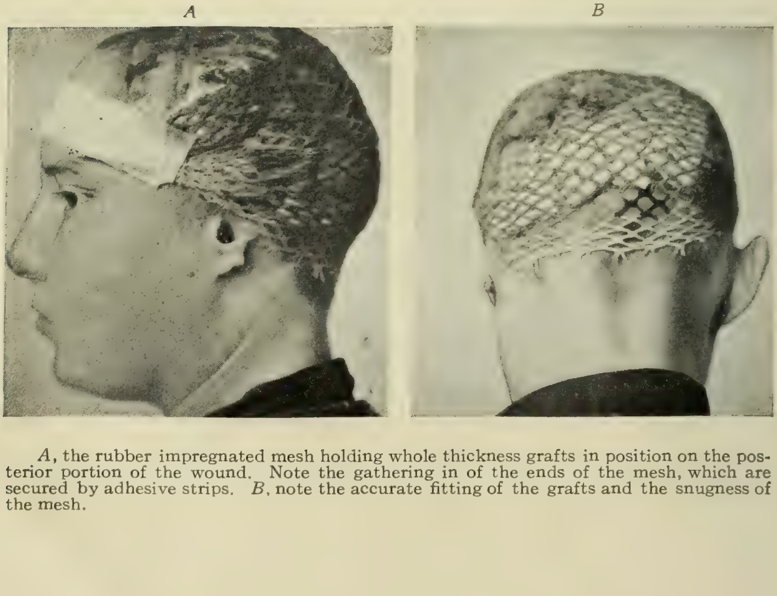
Different grades of retraction of the eyebrows. *A*, Franchomme and Parisot's case, slight retraction. *B*, Fouchard's case, note Mongolian expression. *C*, Durand's case, marked ectropion.

FIG. 9.



Outline of the incision made in pedunculated flap experiments.

FIG. 10.



*A*, the rubber impregnated mesh holding whole thickness grafts in position on the posterior portion of the wound. Note the gathering in of the ends of the mesh, which are secured by adhesive strips. *B*, note the accurate fitting of the grafts and the snugness of the mesh.

years. Both accidents occurred in manufacturing plants and were due to rapidly revolving shafts which were unboxed.

In Case I the *line of tearing* included both eyebrows, while in Case II the tearing began at the hair line. In Case I there was slight laceration of the right ear, while in Case II the left ear was torn off and also a portion of the cheek was involved. In both cases the tear was across the neck and not in a point to the root of the neck.

There was no *loss of consciousness* in either case. There was marked *hemorrhage* in both cases, but of comparatively short duration. It was necessary to *tie the arteries* in Case II. In Case I the *immediate pain* was intense, while in Case II it was so slight that the patient was unaware that her scalp was avulsed. The *subsequent pain* was severe in each but disappeared within a short time. There were *periosteal defects* in both but without subsequent *exfoliation of the bone.* There was little or no *shock* in either. No attempt was made to *replace the scalp* in either case. In both cases the first growth of granulations on the periosteum was exceedingly slow.

Twenty-one months had elapsed after the accident before Case II came under my care, and during that time autodermic Thiersch grafts and both thin and thick zoodermic grafts had been unsuccessfully tried. There had been a slight growth of epithelium about 1 cm. in width around the wound edges.

In comparing the condition of the wounds, the types of grafts used, and the results obtained in the treatment of these cases, I will consider in Case II only the treatment carried out after May 1, 1909, at which time the patient came under my care.

The pictures presented by these two cases are very different. In Case I the difficulty was in stimulating the growth of the granulations before attempting to graft, while in Case II (21 months after the accident), the problem was how to deal with badly infected, exuberant, œdematous granulation tissue, and to bring it into a suitable condition for grafting.

In Case I only Thiersch grafts were used, while in Case II only whole thickness grafts were employed. Isodermic grafts were tried in both, but were unsatisfactory except for a partial take in Case II. Autodermic grafts, on the other hand, were uniformly successful. The grafts in Case I were placed on scraped granulations, while in Case II all the grafts were applied to undisturbed granulating areas. The Thiersch grafts applied in Case I were cut under ether anæsthesia by the method employed at the Johns Hopkins Hospital, and wet technic was used. The greater number of whole thickness grafts on Case II were obtained under local anæsthesia, and dry technic was carried out as far as possible. Both cases were in the hospital about the same length of time.

In Case I small ulcerations appeared here and there over the grafted surface, off and on, after discharge from the hospital. In Case II small ulcerations appeared while in the hospital and one or two later, but these were on the ungrafted scar tissue, and not on the grafted surface.

I was fortunate enough to have an opportunity of examining Case I three years after her discharge from the hospital, and could in this way make a relative comparison of the healing brought about by Thiersch grafts and by whole thickness grafts.

The grafted surface in Case I was covered with a smooth, thin, shiny skin, which was freely movable over nearly the entire area. On this were several superficial ulcers. The patient said that these ulcers would heal slowly and then other areas would break down, so that ever since her discharge there had been one or more ulcers.

Sensation was present practically over the entire grafted area, and there has been constantly a feeling of weight on the vertex.

The grafted area in Case II, at time of discharge, was covered with stable whole thickness skin, which was normal in appearance and was soft and movable. The grafts which had lost their superficial layers were somewhat more pinkish, but were equally stable, and there seemed very little likelihood of ulceration.

The marginal cicatrix and areas of scar tissue were much less stable and more likely to break down.

Since discharge the patient writes that a small ulcer would occasionally appear in this scar tissue, but never in the grafted area.

Acute sensation was confined to the cicatricial border, and there were no uncomfortable sensations of weight or tightness.[3]

From the above, one can see at a glance that Case II was in better condition at time of discharge than Case I even after three years had elapsed, which convinces me that whole thickness grafts are the most satisfactory in the treatment of these cases.

### HISTORICAL DATA.

It is generally supposed that the practice of scalping was peculiar to the American Indian, but it has been shown by Burton that this custom was not uncommon among the Asiatics, Europeans, and Africans, from the earliest times.

Friederici believes that the custom of scalping was unknown among Mongolians. He says that scalping is mentioned twice in the Bible, II Maccabees, 7, 7, and Deuteronomy, xxxii, 42, but that there is nothing at all in the original and in the Septuaginta which could be interpreted as showing the existence of the custom of scalping among the Israelites; furthermore, that Herodotus gave the only clear description of a scalping people (Scythians) of the old world, and that everything else on this subject appertains only to hints, beginnings, or remnants.

The Abbe Em. Domenech ("Seven Years' Residence in the Great Deserts of North America," chap. 39) quotes the "decalvare" of the ancient Germans, the "capillos et cutem detrahere" of the code of the Visigoths, and the Annals of Fluor (Flude) to prove that the Anglo-Saxons and the French still scalped about A.D. 879.

Friederici says, after an extensive investigation, he has been unable to confirm these annals.

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[3] On September 26, 1910, the patient writes that her head is in splendid condition, and that she is working. Sensation is present over the entire grafted area, and is normally acute 2¼ inches beyond the cicatricial border. This shows quite rapid progress from the edges of the wound. Small superficial ulcers still occasionally occur in the scar tissue, otherwise there is no trouble whatever.

There is no doubt but that the American Indians were accustomed to scalp their enemies long before the discovery of this country by Columbus, and each tribe had its own method of scalping which was passed down from generation to generation. The amount of scalp removed, by the different tribes, varied from about the size of the tonsure of a monk to the whole scalp.

Up to thirty years ago scalping by Indians was of common occurrence on our Western frontier, although the cases were seldom reported in medical literature, but of late years this method of scalping has, happily, become exceedingly rare. Industrial scalpings, on the other hand, have increased in number, and in the last fifty years the majority of cases reported in medical literature have occurred in manufacturing centres, and when scalping is spoken of to-day industrial scalping is usually meant. The number appears to have increased chronologically with the greater development of machinery and manufacturing plants.

The number of cases is not great, and in over 26,000 house cases admitted to the Johns Hopkins Hospital, in the service of Dr. Halsted, there has not been a single case of complete scalping.

The first case of scalping due to machinery, recorded in medical literature, is that of Downs, which occurred on June 23, 1838.

Netolitzki was the first to employ grafts in the treatment of scalping, and on April 11, 1869, transplanted small elliptical shaped pieces of whole thickness skin from the back of the patient's hand. Later, on the same wound, Phillipp tried zoodermic grafts from various animals, for the first time on such a case.

Bartlett, in 1871, was the first in the United States to employ autodermic Reverdin grafts in the treatment of scalping. This also seems to be the earliest recorded case of scalping thus treated.

Socin, in 1889, was the first to employ Thiersch grafts in the treatment of scalping.

The *anatomy of the scalp* will not be considered here, on account of lack of space.

### DEFINITION, ETIOLOGY, MECHANISM.

There have been many definitions of scalping, for the most part based on the amount of scalp avulsed, but a simple and satisfactory idea of the injury may be expressed as follows: By scalping we mean the forcible separation of the scalp from the cranial vault by a violent, quick force, from which results a tearing of the skin, with little or no mutilation of the surrounding teguments.

There are two clinical varieties of scalping: *incomplete,* where the whole or a portion of the scalp is separated from the vault, although it remains attached to the adjacent skin by a pedicle, which may be more or less extensive; *complete,* where the whole or a portion of the scalp is entirely separated from the cranial vault and the adjacent skin. There are several grades of each of these varieties, depending on the amount of the scalp involved.

Special conditions are necessary for the production of this accident by machinery. The patients have been almost exclusively workers in factories, and all have been females, with the exception of one case, a Chinaman, who caught his queue in revolving machinery and was totally scalped.

The scalp is caught between two forces which oppose each other, the force of the machine and the speed of rotation, against the weight of the body and the struggles of the individual. Violent and quick traction is necessary. By the strong pull on the hair, at first there is separation between the galea and the periosteum. The scalp does not give way until its elasticity has reached its limit, when the muscle parts and the skin tears. The line of separation is, as a rule, at the junction of the scalp with the skin of the face and neck, or in other words where it is thinnest, and in many instances it finishes low on the neck, in Spencer's case reaching the fourth dorsal vertebra.

The amount avulsed varies with the amount of hair caught and with the direction and intensity of the force. In incomplete scalping a pedicle is left at the point where the force was least, and therefore not where the tearing begins. If the pedicle is behind, the tearing begins in front, and vice versa.

A series of experiments, by Fouchard, were made on cadavers as follows: In the first series violent sudden traction was made on the scalp in a direction following the median axis of the body, by means of the plaited hair. Three attempts resulted in the tearing out of nearly all of the hair in each instance, without injury to the skin. The fourth, where the traction was not so strong and less sudden, produced no result.

In the second series the traction was operated in the same way, but the pull was made obliquely from back to front. Three attempts were made with a negative result in each, except for a limited tearing of the hair alone at the periphery of the zone of implantation.

In the third series, five experiments with traction from front to back produced five scalpings, two complete and three incomplete. The tearing in each case began at the superciliary ridges. Fouchard concludes that the tearing of the scalp is produced by a sudden and violent traction, which is exerted obliquely from front to back. The superciliary ridges act as the cutting instrument, and the skin is cut by them where it is thinnest, and the tearing follows toward the neck. He says this is the usual method in actual practice.

When the tearing begins at a different level, such as the hair line, the above described action does not occur, and the cause is obscure.

The only case in which the hair alone was pulled out without injury to the scalp was that of Vauthier, and it might be explained along the line of Fouchard's first series of experiments.

A comparison of the number of complete and incomplete scalpings by machinery is interesting, there being 80 complete and 10 incomplete.

The separation usually takes place in the loose subaponeurotic layer, but occasionally the periosteum is removed to a greater or less extent, and also the fleshy portions of the occipitofrontalis and temporal muscles.

The anatomic elements are easy to differentiate. The skin edges are remarkably clean and regular, and there is usually little or no mutilation of the surrounding tissues.

By the strict enforcement of certain rules, a large number of the recorded cases of scalping could have been avoided. The shafts and belts should be housed in as far as possible, or placed out of reach.

The female operators should be compelled to arrange their hair tightly, and always to keep it covered with a simple cap of some smooth material while in the working room.

### ANALYSIS OF CASES.

*Scalping due to burns,* 8 cases. *Hair torn out without laceration of the scalp,* 1 case.

*Complete Scalping,* 91 cases.—*Scalping by Indians,* 7 cases. *Scalping by machinery,* 80 cases.

For convenience I have divided the cases of complete scalping, caused by machinery, into three general classes: first, those in which the line of tearing included one or both of the eyebrows; second, those in which the line of tearing passed above the eyebrows; third, those in which the line of tearing was not given.

*Scalping by other forces,* 4 cases.

*Incomplete Scalping,* 30 cases.—*Scalping by the claws of animals,* 2 cases. *Scalping in which the method of injury was not given,* 4 cases. *Scalping by machinery,* 10 cases. *Scalping by other forces,* 14 cases.

### SUMMARIES.

*Scalping due to burns,* 8 cases. *Males,* 6; *females,* 2. The *youngest* was 7 months, and the *oldest* 50 years. *Age in decades:* Up to 9 years, 2 cases; 10 to 19 years, 1; 20 to 29 years, 2; 30 to 39 years, 1; 50 to 59 years, 1; no age stated, 1. *Date of cases in decades:* 1850 to 1859, 1 case; 1860 to 1869, 1; 1870 to 1879, 2; 1900 to 1909, 4. *Loss of consciousness* and *shock* were not stated. *Immediate pain,* very slight if any. *Periosteal defects at time of accident,* 8 cases. *Exfoliation of the bone,* 6 cases; both tables came away in 3; in 1 of which there was exfoliation of an area 5¾ x 4½ inches, and in another an area 17 x 11 cm. *Complications:* Cicatricial bands to sternum, 1 case; ectropion, 2;

erysipelas, several attacks, 1; sepsis, 1; abscess of brain, 1; convulsions due to pressure of scar on brain, 1; lowering of forehead due to continual pressure of scar tissue, 1. *Treatment and result:* Cases grafted, 2, both healed. *Type of grafts used,* not stated, 1; human skin and mucous membrane, rabbit, guinea pigs, dogs, and frogs, 1. *Healed by grafting* 2 cases; *healed by cicatrization,* 1; *unhealed,* 1; *result not stated,* 2; *died* 2. *Time of healing by grafting,* 4 years, 1; 1 year, 1; one case died from sepsis and the other from abscess of the brain. *Burned by coals,* 4 cases; *electricity,* 2; *carbolic acid,* 1; *boiling grease,* 1.

The absence of pain, shock, and general symptoms in the cases burnt by fire is quite remarkable. The reaction is more marked in the electric burns and carbolic acid burns.

*Hair torn out without laceration of the scalp,* 1 case. This case is unique, and is the only one on record caused by machinery in which the hair alone was torn out, leaving the scalp intact.

### COMPLETE SCALPING, 91 CASES.

*Scalping by Indians,* 7 cases. These cases are interesting, and the treatment of boring with an awl the necrosed bone advocated by Robertson so many years ago is undoubtedly beneficial. To-day, however, in areas of any size, a small trephine or a Hudson burr will be found more advantageous than an awl.

### *Total Summary, Complete Scalping by Machinery.*

*Complete scalping by machinery,* 80 cases. *Scalping in which the line of tearing included one or both of the eyebrows,* 53 cases. *Scalping in which the line of tearing passed above the eyebrows,* 19 cases. *Scalping in which the line of tearing was not given,* 8 cases. *Male,* 1; *females,* 79. The *youngest* was 9 years, and the *oldest* 57 years. *Age in decades:* 1 to 9 years, 2 cases; 10 to 19 years, 32; 20 to 29 years, 22; 30 to 39 years, 3; 40 to 49 years, 2; 50 to 59 years, 1. *Age not stated,* 18 cases. *Date of cases by decades:* 1830 to 1839, 1 case; 1840 to 1849, 1; 1850 to 1859, 1; 1860 to 1869, 7; 1870 to 1879, 16; 1880 to 1889, 7; 1890 to 1899, 21; 1900 to 1909, 26. Twenty-one of these cases have occurred in the United States. There was *loss of consciousness* in 6 cases. *Shock,* 14 cases; in 9 of these it was severe. *Immediate hemorrhage,* 16 cases, in 11 of which it was severe. *Subsequent hem-*

*orrhage,* 2 cases. *Arteries were tied* in 10 cases. *Immediate pain,* 12 cases, in 3 of these it was severe. *Subsequent pain* occurred in 5 cases, all being severe. There were *periosteal defects at time of accident* in 29 cases; in 4 the *entire periosteum* was torn off, and there was *exfoliation of the bone* in 2. In 21 the *size of the defect* was not stated; in 12 of these there was *subsequent exfoliation of the bone.* In 4 cases *very large pieces of the periosteum* were torn off, with *exfoliation of the bone* in 2. There were *periosteal defects following suppuration* in 5 cases, with *exfoliation of the bone* in 4. The *entire scalp was replaced in one piece* in 21 cases, in all but one of these there was total failure. In this case there was nearly complete healing after 98 days. *Left ear involved,* 12 cases; *right ear involved,* 11 cases; *both ears involved,* 2 cases; *ear involved, but which side not stated,* 1 case. *Retraction of the upper eyelids,* 9 cases. *Infection of the eye resulting in destruction,* 2. In practically every area grafted *small ulcerations have appeared* on the grafted area after the original healing. These ulcerations have been more or less resistant to treatment. *Cases grafted,* 57, with complete healing in 33 cases; *strips of the denuded scalp,* in combination with other grafts, being used in 2 of these cases. *Death occurred* in 8 cases, as follows: in 1839, 1 case; 1841, 1; 1863, 1; 1869, 1; 1873, 1; 1876, 1; 1878, 1; 1908, 1.

*Complete scalping by other forces,* 4 cases. *Males,* 1; *females,* 3. The *youngest* was 4 years and the *oldest* 60 years. *Age in decades:* 1 to 9 years, 2 cases; 30 to 39 years, 1; 60 to 69 years, 1. *Date of cases by decades:* 1840 to 1849, 1; 1900 to 1909, 3. *Loss of consciousness, shock,* and *hemorrhage* and *pain* were not stated in any of these cases. *Periosteal defects at time of accident,* 3 cases, in 1 of which there was *exfoliation of the bone. Exfoliation of the bone,* 1 case, the whole of the external table was exfoliated. *Complications: tetanus,* 1 case. *Treatment and results: cases grafted,* 1 case. *Type of graft used,* sliding plastic flaps 8 days after the accident, with recovery in 1 month. *Healing by cicatrization,* 3 cases. *Time of healing by cicatrization:* 5 months, 1; 6 months, 1; *time of healing not stated,* 1 case.

Haubold's case is the only one on record which was completely covered by plastic flaps from the surrounding hairy scalp, and this of course was due to the retraction of the wound and to the fact that only a portion of the scalp was removed.

### INCOMPLETE SCALPING, 30 CASES.

*Scalping by the claws of animals,* 2 cases, both *males. Age,* 7 years in one case, the other an adult; both were scalped by the claws of bears. In the first case the patient was healed by cicatrization in 3 months, and hair grew here and there over the wound. In the other the flap was replaced but sloughed later. There were other wounds on the back, hip, and arm. The patient died 11 days after the accident.

*Incomplete scalping in which the method of injury was not given,* 4 cases. *Females,* 3; *age* not stated in 1. The *youngest* was 10 years and the *oldest* 58 years. No details were given in regard to *loss of consciousness, pain, hemorrhage, shock,* or *periosteal defects.* The *flap was replaced and sutured* in each case. There was sloughing of part of the flap and *exfoliation of the bone* in 1 case, with healing in 9 months. One case healed in 2 months; 1 in 1½ months; 1, failure of the flap and no result was given. *Complications:* erysipelas, 1 case; suppuration, 1 case.

*Incomplete scalping by machinery,* 10 cases. All *females.* The *youngest* was 10 years, the *oldest* 40 years. *Age in decades:* 10 to 19 years, 5 cases, 20 to 29 years, 1; 30 to 39 years, 1; 40 to 49 years, 1. *Age not stated, 2. Date of cases by decades:* 1860 to 1869, 1 case; 1870 to 1879, 1; 1880 to 1889, 1; 1890 to 1899, 4; 1900 to 1909, 3. There was *loss of consciousness* in 2 cases. *Shock,* slight, 1. *Hemorrhage,* 5, severe in 3, slight in 2. *Arteries tied* in 1 case. *Pain,* 2, slight in both. *Periosteal defects,* 4. *No exfoliation of the bone. Complications: left ear involved,* 3; *right ear involved,* 1. Left shoulder badly injured, 1. Badly lacerated wrist and contusions on thigh, 1. Infection, 1. Meningitis, 1. *Treatment and results:* The *flap was replaced* in each case, and healed in 6, sloughed entirely in 2; one of these cases was healed later by skin grafting. Sloughed more than half in 1, which was healed later by skin grafting. One case died within 24 hours. *Time of healing by grafting:* 2½ years, 1 case. Time not stated, 1. *Types of grafts used:* Thiersch, 1 case; autodermic Reverdin, 1. *Time of healing by replaced flaps:* 10 days, 1 case; 18 days, 1; 54 days, 1; 2 months, 1; time not stated, 2. *Death* occurred in 2 cases, 1 on the thirteenth day from meningitis; 1 case did not regain consciousness after the accident and died on the following day.

*Incomplete scalping due to other forces,* 14 cases. *Males,* 11; *females,* 3. The *youngest* was 8 years, the *oldest* 76 years. *Age in decades:* 1 to 9 years, 1; 10 to 19 years, 4; 20 to 29 years, 2; 30 to 39 years, 2; 70 to 79 years, 1. *Age not stated,* 4 cases. *Date of cases by decades:* 1830 to 1839, 4; 1860 to 1869, 2; 1870 to 1879, 1; 1880 to 1889, 3; 1890 to 1899, 3; 1900 to 1909, 1. There was *loss of consciousness* in 6 cases. *Shock,* severe, 1. *Hemorrhage,* 5 cases, 3 of which were severe, and 2 slight. *Immediate pain,* 3 cases; *subsequent pain,* 2. *Periosteal defects at time of accident,* 6 cases, with no *exfoliation of the bone. Complications:* infection, 3 cases; epileptiform attacks, 1; meningitis, 1; Colles's fracture, 1; baldness of the flap following the accident, 1. *Treatment and results:* the *flap was replaced* in 13 cases; patient refused treatment, 1 case. *Healed,* 10 cases; *result unknown,* 2 cases; *death,* 1 case. *Time of healing:* 4 days, 1 case; less than 6 days, 1; a few days, 1; 9 days, 1; 11 days, 1; 1 month, 1; 5 weeks, 1; time not stated, 4; *death occurred* on the twenty-fourth day from meningitis in 1 case; result unknown, 2 cases.

There are probably a great number of cases of incomplete scalping reported in the literature, but listed under lacerated wounds of the scalp, which are not included in our series.

## SYMPTOMS.

There are a number of immediate symptoms which differ somewhat in intensity in incomplete and complete scalping, depending upon the extent of the injury, the method of causation, and the force by which it is inflicted.

Pain is rarely complained of at the time of the accident, and may be so slight that the loss of the scalp is not realized by the patient until the hand is placed on the head. It may become very severe within a few hours. This is especially marked during the dressings and may be of sufficient severity to require either a cocaine spray or a general anæsthetic, and lasts for an hour or two afterwards. The pain may continue several weeks, but as a rule then ceases entirely. Fortunately the subsequent pain is very slight in most of the cases, and the dressings cause little discomfort.

The hemorrhage may be severe enough to give rise to a marked temporary anæmia, but is usually very slight when we take into consideration the extent of the wound and the vascularity of the scalp. It is usually venous hemorrhage, as the external coat of the veins is very closely connected with the firm tissue of the subcutaneous layer, and thus the lumen is held open. The arteries, on the other hand, although somewhat adherent to the subcutaneous tissue, behave differently on account of the inequality of elasticity of the various coats. As the traction goes on, although it may be very rapid, the middle and internal coats give way first and retract, thus diminishing the calibre and partly blocking the lumen.

There is seldom serious collapse from hemorrhage, although death from hemorrhage is the only way simple avulsion can be immediately fatal. The anæmia due to the hemorrhage may persist and materially retard the treatment.

Sometimes in spite of the fact that there is little or no pain and no hemorrhage, there quickly follow varying degrees of shock and even complete collapse. On the other hand the patient may be so slightly affected that in some cases she has insisted on replacing the scalp and walking to her home, or to the hospital.

There is usually very profuse discharge from the granulating surface, which is often depleting to the general health of the patient. In the majority of cases the result of simple avulsion on the general condition is slight, but the danger comes from the complications which may follow.

## COMPLICATIONS.

These may be divided into three groups. First, those which occur at the time of the accident; second, those which occur during the progress of the treatment; third, those which are due to cicatricial contraction.

Those in the first group are due to other forces than the simple traction which causes only the avulsion. The patient may be lifted and then dropped or thrown violently against some neighboring object. Some other portion of the body may come in contact with the moving machinery, and thus various injuries result, such as fracture of the skull, fracture of the clavicle or rib, avulsion of the thumb, etc. This group of complications is not as usual as might be supposed, as in the majority of cases the scalping is the only injury.

Those in the second group are principally due to infection. These are fortunately much less frequent than they were before the days of aseptic and antiseptic surgery, although they still occasionally occur in spite of every precaution.

It was then the rule rather than the exception to have severe inflammation with fever and suppuration, lasting for months and followed by great weakness, loss of health, and degeneration of organs due to prolonged suppuration.

Erysipelas appeared sometimes more than once during the course of the treatment. Phlegmon and abscess, septicæmia and pyæmia were common. In some instances the infection extended into the interior of the skull through the emissary vessels, or through a defect following necrosis of the bone, causing meningitis, brain abscess, and other cerebral infections, which sooner or later resulted in death.

There may be necrosis of bone with exfoliation in those cases where the periosteum is torn, especially when the bone has become dry and the granulations have not covered it. The periosteum may be destroyed later by suppuration, and bone necrosis follow.

Occasionally there is secondary hemorrhage due to the ulceration of vessel walls following infection. Hemorrhage may take place from granulation capillaries when the head is lower than the body, and also when the blood-pressure is increased during the administration of an anæsthetic, or from nausea following anæsthesia.

Tetanus has developed in several cases, and mastoiditis also is an occasional complication. There have been symptoms of iodoform and carbolic poisoning following the too free or long-continued use of these drugs as dressings. An occasional septic pneumonia has also occurred.

Those in the third group are for the most part due to cicatricial contraction and are often very severe. They cause hideous deformities due to ectropion of the upper eyelids and occasionally an eye is subsequently lost from infection. The upper eyelid is most often pulled up and out, the result being that the axis of the palpebral cleft is deviated, becoming oblique from top to bottom and from outside to inside, giving a Mongolian expression (Fig. 8). The contraction, on the other hand, may tend to draw up the surrounding soft parts, and thus make a smaller area to be covered. Occasionally the ears are somewhat displaced by the contraction. The worst contractions follow those cases where the scalp is torn off beginning from or including the eyebrows, and the principal effort of the surgeon should be to overcome this tendency by the application of suitable grafts over this area before the contraction begins to be serious. Aside from those already mentioned there are remarkably few bad consequences after the healing is complete.

There is occasionally quite marked sensitiveness to heat and cold, neuralgia, feeling of weight, headache, and vertigo.

## PROGNOSIS.

Before the introduction of surgical cleanliness, Follin and Duplay made the statement that complete scalping was always terminated by death. To-day, since the antiseptic and aseptic era began, the prognosis as to life has been excellent. The utilization of skin grafting in the treatment of such wounds has also greatly influenced the results. There is little immediate danger from a simple scalping.

In incomplete scalping there is nearly always prompt healing when the flap is replaced and properly treated, although total sloughing of the pedunculated flap is reported in several instances.

In the complete variety one of the methods of skin transplantation is necessary to bring about the desired result within a reasonable time.

The severe infections, once so common, may now be almost eliminated by modern methods of treatment.

The unsightly deformities due to the retraction of the eyelids can often be avoided by the early application of well-placed skin grafts.

The new scalp is never as stable as the original one, except when whole thickness grafts are successful, and often there is much trouble caused by ulceration on the unstable healing due to pressure of the wig or some slight injury or infection.

The sensation of grafted areas on the cranium extends slowly, and comes in from the periphery, as in other parts of the body, and not from the underlying tissues. Thus the greater part of the grafted area may remain anæsthetic for years. In no case reported has acute sensation been present further than 2.5 cm. from the normal skin, except in Cases I and II. This lack of sensation in several instances has been the cause of infection and ulceration; for example, one patient ran a hat pin through the grafted area without being aware of it, and infection followed. For this reason it is necessary to impress on the patient the great importance of carefully protecting the newly transplanted skin until it is capable of normal resistance.

## TREATMENT.

Many ancient as well as modern authors, from Hippocrates to the present day, have written of scalp wounds, and definite rules have been formulated for their treatment. We have to deal, however, with a type of scalp wound which requires patience, much care, and special treatment.

The Treatment of Incomplete Scalping.—In cases of incomplete scalping where a pedicle remains, even though it is very small, the treatment in the majority of instances is comparatively simple, as the vitality of the flap is preserved to a considerable extent through the vessels in the pedicle, and by means of free anastomosis the blood supply is soon re-established. Success, however, is not always certain, as for instance in Gussenbauer's case there was slough of the entire scalp although the pedicle was 9 cm. wide. The richness of the pedicle supply depends largely on its size and location. All that is necessary, then, in addition to this blood supply, is absolute surgical cleanliness, with proper drainage and accurate approximation of the wound edges with sutures. It is useless to go into a detailed account of the cleansing, as it only varies in its minor details with the individual surgeon. However, one or two points should be borne in mind. The denuded skull should be thoroughly protected from further contamination during the shaving and careful cleansing of the flap by means of sterile dressings wet with warm salt solution. Then after the flap is cleansed it should be wrapped in warm moist dressings and held out of the way, without twisting the pedicle, while a painstaking and thorough toilet of the wound and surrounding tissues is being made. No strong antiseptics should be used in this preparation, but a soft brush with soap and water and plentiful flushing with sterile water, boracic, or normal salt solution is all that is necessary.

A first dressing of silver foil and sterile gauze, secured by a snug bandage, will be found satisfactory, but many surgeons prefer a dressing of sterile gauze moistened with normal salt solution. As a rule the healing is complete within a few days, but in those instances where there is slough of a portion of the flap, the resulting granulating wound must be treated as seems best under the existing conditions. If the wound is of any considerable size, skin grafting may be advisable to hasten the healing.

THE TREATMENT OF COMPLETE SCALPING.—When a case of complete scalping is presented, the question at once arises as to the advisability of replacing the scalp. The scalp has been replaced in 21 cases, but that of Malherbe is the only one which has resulted even in partial success, and even this is doubtful, as LeJars, in "Urgent Surgery," vol. i, 1910, page 87, speaking of this case says: "The scalp died, but turned into a parchment-like covering which remained adherent to the cranium, and under which healing took place without complications."

When we consider the poor blood supply of the periosteum, it is easy to understand failures in replacing scalps, especially when we bear in mind the liability to infection.

The old method of allowing these wounds to heal by cicatrization is no longer to be considered, as it is unsafe and requires so much time, and also gives an unstable result. Therefore it is necessary to obtain material with which to cover the wound by one of the methods of skin grafting.

*Surface to be Grafted.*—Whether to graft immediately or to wait until granulations have formed is a matter to be considered. Several cases have been successfully grafted at once or within a few hours after the accident, but the consensus of opinion is that it is safer to wait for a better blood supply.

I believe that there is little if any time gained by immediate skin grafting in these cases, although it is advisable to transplant strips of the torn off scalp. It is much better to wait until the wound is covered with healthy granulations before attempting to graft. If a fresh case came under my care, I should try to preserve at least a portion of the scalp, and apply it in strips when the conditions seemed favorable.

The grafts may be placed on undisturbed granulations or on granulations slightly rubbed with gauze sponges, or on the firm base after the granulations have been removed.

It is undoubtedly advantageous in cases of avulsion to place the grafts on undisturbed granulations, as there is no pain in the preparation of the surface; no loss of blood, which is an important point in cases already much depleted; little likelihood of blood or serum collecting under the grafts, and no danger of stirring up infection. It seems reasonable to believe that the capillary loops of undisturbed granulations are in better condition to immediately penetrate the graft than if these loops have been disturbed or curetted off and have to regenerate before they can penetrate and effectually nourish the newly transplanted skin. This regeneration takes about 24 hours, which means that considerable time is lost before the newly formed vascular loops are even ready to enter the grafts. This time is gained, therefore, by placing the grafts on undisturbed, healthy granulations.

Nature begins her attempts at healing by the formation of granulation tissue, which first appears at the margins of the wound and along the line of the cranial sutures. These granulations spread to join other numerous similar smaller areas, which soon spring up over the surface of the periosteum, and finally cover the entire wound. Should there be a defect in the periosteum, granulations often cover the denuded bone, but sometimes there is exfoliation of the outer table due to necrosis, in which case the granulations spring from the diploe.

It is important to suture any rent in the periosteum if possible, but if there is a loss of substance, dress the uncovered bone with wet dressings, so that it will not dry out and become necrotic. A piece of rubber protective over the denuded bone will also keep the bone moist until the granulations have formed over it.

*Stimulation of Growth of Granulation Tissue.*—In some instances there is much difficulty in causing the granulations to grow on the periosteum satisfactorily, and as the success of every method of grafting in these cases depends on the healthy state of the granulations, it is of prime importance that the necessary condition be brought about as soon as possible. This result depends to a large extent upon the general health of the patient, therefore a vigorous building-up treatment should be inaugurated in addition to the local treatment.

*Classification of Skin-Grafts.*—In a general way grafts may be divided into *thin grafts,* where only a portion of the thickness of the skin is utilized, as obtained by the methods of Reverdin and Thiersch, and *thick grafts,* where the whole thickness of the skin is used. This latter division includes whole thickness sessile flaps and whole thickness pedunculated flaps.

Grafts may be further divided into *autodermic,* where the graft is obtained from the same individual; *isodermic,* where the graft is obtained from another individual of the same species, and *zoodermic,* where the graft is obtained from a lower species.

*The Use of Isodermic Grafts.*—There is much difference of opinion as to the advisability of utilizing isodermic grafts, and many surgeons insist that only autodermic grafts should be used. Of course autodermic grafts are more likely to succeed. However, a study of the results obtained by means of isodermic grafts at the Johns Hopkins Hospital, and also my own experience with these grafts, have convinced me that both thin and thick isodermic grafts are well worth trying, and that very good lasting results may be secured if the grafts are obtained and transplanted with the proper technic.

*Zoodermic Grafting.*—Both thin and thick grafts have been tried on a number of cases of scalping, but with no permanent success. The skin of dogs, lambs, rabbits, and guinea pigs, etc., has been utilized, and while many of the grafts at first would apparently take, in the course of a few weeks they would be absorbed. I think that zoodermic grafts have a better chance of ultimate success in other regions of the body which are less exposed than the cranium.

Whether to cover the entire wound with grafts at one time is a matter to be determined by the individual surgeon. It has been done in one or two instances, but the majority of surgeons prefer to graft only a portion at a time, say a half or a third. There is no reason why the entire area should not be covered at one time with Thiersch grafts, but some difficulty might be encountered in securing enough whole thickness skin to cover an entirely denuded cranium at one time.

*Method of Preparing Skin before Cutting Grafts.*—A simple and satisfactory method of cleansing the skin before cutting the grafts is to shave the part selected, then scrub carefully with green soap and water. Rinse with sterile water, sponge with ether followed by alcohol. Then rinse thoroughly with sterile normal salt solution and dry with a sterile towel.

*Method of Preparing Healthy Granulations to Receive Grafts.*—On the day preceding the operation, remove all secretions and crusts. Wash thoroughly with sterile boric solution and dry. Paint with tincture of iodine and dress with balsam of Peru and castor oil, 2 to 6. Allow this dressing to remain in place until the time of operation. Then remove it and wash the wound carefully with warm boric solution, or normal salt solution sponges, without causing bleeding. Follow this by an irrigation of normal salt solution and then dry carefully with sterile gauze.

Place several layers of dry gauze over the wound, and press them down firmly on the granulations, removing them only when the grafts are ready for application.

I will not take up the *technic of grafting,* as I have fully covered this matter in vol. xv, of the Johns Hopkins Hospital Reports.

*Transplantation of Hair-bearing Skin.*—In those cases in which the eyebrows have been torn off, small whole-thickness flaps of hairy skin from the pubis or any other hairy region, with a portion of the subcutaneous tissue, may be successfully transplanted to the eyebrow region and the hair will grow. Fine hair also grows on whole thickness flaps taken from the thigh. Enz says that hair grows at first on the transplanted pieces of scalp, but that it soon falls out. Lotheissen had a similar experience in transplanting skin from the pubic region. Burdel, on the other hand, found in his case that hair grew on the areas transplanted and did not fall out. I have successfully transplanted hair-bearing skin on other parts of the body, and later there was a vigorous growth of hair. Several attempts have been made to transplant single hairs including the sheath, but without success. No hair whatever will grow on those areas covered with Thiersch or Reverdin grafts, and this is easy to understand, as the hair-growing portion of the skin is not transplanted.

*The Treatment of Ulceration of the Grafted Surface.*—The treatment of small ulcers, which appear in the cicatricial tissue and here and there over the areas grafted with thin grafts, is sometimes very tedious and unsatisfactory. Where these ulcers are of any considerable size, say 1 cm. in diameter, much time can be saved by grafting with small deep grafts as soon as the granulating base is healthy. This healing will be more stable than on those ulcers which heal spontaneously, and I have not yet seen an instance in which the ulcer has broken down again after this treatment.

Another method which has given me satisfaction is the use of 8 per cent. scarlet red salve, made up in simple vaseline or in balsam of Peru ointment. By this means the epithelium seems to be stimulated and a good stable healing brought about. However, a combination of these two methods is probably the quickest and best. Apply the small deep grafts first to the untouched granulations, and dress with overlapping strips of protective. Then from 24 to 48 hours later remove the protective and dress with scarlet red ointment. This combination is also advantageous in hastening the healing of those whole thickness grafts which cast off some of the outer layers and are slow in "topping off."

*Treatment of Complications.*—No hard and fast rules can be laid down for the treatment of complications, but each must be taken in hand promptly.

All the modern advances in the treatment of infections with autogenous and stock vaccines, serums, etc., must be utilized in the severe cases, in addition to the local treatment.

Ectropion and similar deformities can be prevented by early and proper grafting, but should they occur, relief can only be obtained by a plastic operation or further grafting.

## ANIMAL EXPERIMENTS.

Through the courtesy of Dr. Harvey Cushing I was able to carry out the experiments outlined below, in the Hunterian Laboratory of the Johns Hopkins Medical School.

Young animals between 3 and 12 months were used for these experiments. The scalps were shaved and then washed with soap and water, followed by alcohol and ether. Dry technic was employed throughout until the flaps were replaced. Ether anæsthesia was used in each experiment.

Experimental scalping on dogs presents a number of difficulties, especially in the after treatment. The great movability of the dog's scalp and the difficulty in immobilizing the replaced flap are factors to be considered, since absolute immobility is essential, in order that the blood supply may enter the flap within a reasonable time.

The constant scratching and rubbing, with the consequent disarranging of the dressings and even of the flap itself, and the liability to infection must also be thought of. It is indeed fortunate that all of these troubles can be eliminated, to a large extent, in the treatment of the human. It is, therefore, hard to draw accurate conclusions from the experiments, and especially from those cases where the flap was totally removed.

SERIES I.—*Complete Removal of a Flap of the Scalp, with Replacement within 20 Minutes; Résumé.*—Thirteen experiments. The flap removed varied between 1.25 and 6 cm. in diameter. In 11 the flap included all the tissues down to the periosteum and fascia of the temporal muscles. In 2 the fascia of the temporal muscles was removed and the flap was placed on muscle tissue. The superficial muscles were removed from the flap in 10, and were allowed to remain in 3. Four flaps were replaced immediately. Five flaps were replaced after 10 minutes. Two flaps were replaced after 15 minutes. Two flaps were replaced after 20 minutes. All were sutured into position. Four were button-holed and drained. Nine were button-holed but not drained.

*Dressings.*—Four were dressed with balsam of Peru, 2 parts, and castor oil, 6 parts, on gauze, and bandaged. Three were anointed with vaseline and exposed to the air without other dressing. Two were exposed to the air without dressing. One was dressed with moist salt gauze and protective. Three were dressed with amberine.[4]

*Result.*—Total failure of all. In 9 of these the flap dried out, and the four which were dressed with moist dressings macerated.

On removal of the flap in every instance the wound was covered with healthy granulations, even over the periosteum. The wounds healed promptly by cicatrization, leaving a smooth scar which was markedly smaller than the original wound, and in no case was there any noticeable retraction of the eyebrows.

SERIES II.—*Complete Removal of a Flap of the Scalp, with Replacement 24 and 48 Hours Later; Résumé.*—Six experiments. The flaps removed varied between 2 and 3.5 cm. in diameter. They included all the tissues down to the periosteum and fascia of the deep muscles. All were kept in sterile jars containing a moist salt sponge. Four were replaced after 48 hours, and 2 were replaced after 24 hours. The granulations were stimulated by fitting several layers of dry gauze into the defects and covering with overlapping strips of protective. All the flaps were sutured into position and all were button-holed.

*Dressings.*—Four were dressed with overlapping strips of protective and moist salt gauze, and 2 were exposed to the air without dressing.

*Result.*—There was total failure in all. Four flaps macerated and sloughed. Two dried out. The healing was as described in Series I.

SERIES III.—*Flap Separated from the Surrounding Skin, but not*

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[4] Amberine is said to be a mixture of wax, paraffine, and rosin, which can be applied very hot without burning the tissues. It acts as a moist dressing, and it is claimed that it keeps its heat for a considerable time.

*Lifted from Its Bed; Résumé.*—Four experiments. In this series an incision was made around an area of scalp about 6 cm. in diameter down to the periosteum and temporal fascia. This incision cut off entirely the circulation except from immediately below the flap. All the flaps were sutured and freely scarified.

*Dressings.*—Three were anointed with vaseline and exposed to the air, and 1 was exposed to the air without vaseline.

*Result.*—In all there was puffiness of the flap for a few days. A small portion of one flap sloughed, otherwise there was *per primam* healing in all. The final result in all showed an area of normal appearing scalp covered by a full growth of hair. This was surrounded by a slight scar which was freely movable with the rest of the scalp.

SERIES IV.—*Pedunculated Flaps; Résumé.*—Four experiments. The flaps and pedicles varied in size as follows: 5x7 cm. with a pedicle 1.25 cm. broad; 6 cm. in diameter with pedicle 1.5 cm. broad; 6 cm. in diameter with a pedicle 8 mm. broad; 5 cm. in diameter with a pedicle 6 mm. broad. The incision was carried down to the periosteum and fascia of the temporal muscles. Each flap was lifted and held away from its bed for from 10 to 20 minutes. All were replaced without removing the superficial muscles and all were sutured and button-holed. Three were drained with protective wicks through button-holes in the adjacent skin, and the fourth was not drained.

*Dressings.*—All were anointed with vaseline and exposed to the air.

*Result.*—There was thickening of all the flaps for the first few days. There was *per primam* healing in each case with no slough. The result was a freely movable flap of normal appearance and with a normal growth of hair. The flaps were all cut as in Fig. 9.

## CONCLUSIONS.

Series I seem to show that it is useless to replace a totally removed area of scalp and expect it to heal in its bed, even if of small size. Also that granulations appear to grow well on the periosteum under the re-applied flap. For this reason alone, then, the scalp might be replaced *in toto* after proper cleansing and free drainage, and if carefully watched and removed at the proper time would not cause infection and might stimulate the growth of granulations on the pericranium.

In spite of the discouraging results in Series II, I believe that this is a procedure which promises well, as whole thickness grafts can be preserved so satisfactorily that a portion of an avulsed scalp could easily be preserved and applied after the granulations had formed.

Series III indicate that there is sufficient blood supply from below to preserve a flap, which is completely isolated from the surrounding circulation, until the normal circulation is re-established.

Series IV show that comparatively large areas of scalp with small pedicles may be successfully replaced, and the final condition of the replaced flap is practically that of the normal scalp in movability, in appearance, and in its ability to grow hair.

The scarification of the flap is important, as the openings allow the escape of the blood, which easily enters the flap but cannot leave it promptly until the circulation is re-established, and thus prevents congestion. It also allows free drainage of any blood or serum from beneath the flap.

## COMMENTS.

There are two clinical varieties of scalping, incomplete and complete. In this paper we have considered 30 cases of incomplete scalping, 91 cases of complete scalping, and in addition 8 cases due to burns and 1 case where the hair was torn out without injury to the scalp. Ninety-one of these accidents were caused by machinery, and all but one were females.

The scalp is caught between two forces which oppose each other. The line of separation is as a rule at the junction of the scalp with the skin of the face and neck.

The amount avulsed varies with the amount of hair caught and with the direction and intensity of the force. The direction of the force is usually obliquely, from front to back, with the superciliary ridges acting as the cutting instrument. The separation takes place in the loose subaponeurotic layer, but now and then the periosteum is removed to a greater or less extent.

The symptoms differ somewhat in intensity in incomplete and complete scalping, depending upon the extent of the injury, the method of causation, and the force by which it is inflicted.

The pain is usually slight. The hemorrhage may be severe, although it is generally of short duration. Shock may be profound, but in the majority of cases the direct result of simple avulsion on the general condition is slight. The danger comes from the complications, which may be divided into three groups: first, those which occur at the time of the accident; second, those which occur during the progress of the treatment; third, those which are due to cicatricial contraction.

The prognosis as to life since the advent of antisepsis and asepsis has been excellent. The utilization of skin grafting in the treatment of these wounds has also greatly influenced the results.

The treatment of cases of scalping requires patience and much care, and varies markedly in the incomplete and complete varieties.

In cases of incomplete scalping, all that is necessary in the majority of cases, in addition to the pedicle supply, is absolute surgical cleanliness, with free drainage and accurate approximation of the wound edges with sutures, and properly chosen dressings.

The treatment of complete scalping is a much more difficult problem. Both clinical and experimental evidence show that it is useless to replace the scalp *in toto* and expect it to heal, but strips of the scalp may be successfully applied on the periosteum along the wound edges, as immediate whole thickness grafts. I believe that it would be well worth trying to preserve a portion of the avulsed scalp to be applied when the granulations are well started.

The scalp may be replaced, sutured, and drained after very thorough cleansing, and used as a dressing, and if carefully watched and removed at the proper time will not cause infection. I have noticed in experimental work on the scalp that granulations seem to grow more readily on the pericranium under a flap, which subsequently sloughed, than under any other dressing.

As the old method of allowing these wounds to heal by cicatrization is no longer to be thought of, one of the methods of skin grafting is necessary..

Immediate grafting has been successful in a few cases, but it is better to wait until the granulations are in good condition. The periosteal blood supply is very poor and granulations form on it slowly, and the chance of success on a large area of uncovered periosteum is small.

Grafts may be placed on scraped or on undisturbed granulations, and I have found that any type of graft will take as satisfactorily, if not more so, on a healthy undisturbed granulating area than on a fresh wound.

The health of the patient is important and the success of every method of grafting depends upon the healthy condition of the granulations.

Grafts may, in a general way, be divided into *thin grafts,* where only a portion of the thickness of the skin is used, and *thick grafts,* where the whole thickness is used. These may be either *autodermic, isodermic* or *zoodermic.* Autodermic grafts are of course the most likely to succeed, but my own experience has shown me that isodermic grafts are well worth trying.

One or two wounds have been covered with grafts at one time, but usually only a portion is covered at a time.

It is difficult to immobilize grafts on a rounded surface like the cranium, but this has been overcome by the use of rubber impregnated mesh, as can be seen in Fig. 10.

Grafts obtained by Reverdin's method have been used in several cases, but a great deal of time is consumed and the final healing is unstable when compared to the other methods, and there is more likelihood of contraction.

Since 1889 the majority of these wounds have been covered with grafts obtained by the method of Thiersch, and this type of graft is chosen by most surgeons, and undoubtedly gives quicker and better lasting results than can be obtained by the small epidermic grafts of Reverdin.

Whole thickness grafts have been used in conjunction with thin grafts on a few cases, but my own case is the only one, as far as I can ascertain, which has been completely healed by means of whole thickness grafts. There is no doubt but that the healing from whole thickness grafts is the most stable, as is shown in the comparison of the results in Cases I and II, and it seems to me that this method should be employed in the treatment of these wounds.

# THE RESPONSIBILITY OF THE TONSIL IN TUBERCULOUS ADENITIS.

**BY FRANK S. MATHEWS, M.D.,**

OF NEW YORK,

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To attempt to prove that the gland at the angle of the jaw may be infected with tuberculosis by way of the tonsil with which it is in such immediate anatomical and physiological relation would seem a demonstration of the obvious. No one is likely to dispute it, but when we ask whether the tonsil is the uniform, the occasional, or a rare source of cervical adenitis, we may expect widely different opinions.

For its frequent etiological relationship we have the following: Pathological conditions are frequent in children in both tonsils and lymph-nodes. When the tonsil is inflamed from any cause the tonsillar nodes at the angle of the jaw are the first to enlarge. One familiar with the early stages of tuberculous adenitis in children will agree that in at least 90 per cent. of cases the first nodes to enlarge are these same tonsillar nodes. Lymphatic anastomosis being very free, this does not rule out the possibility of infection of these nodes from a back tooth, the pharynx or the nasopharyngeal adenoids. Later in life infection of both tonsil and lymph-nodes is less common. Wood, of Philadelphia, says on the basis of personal observations, that the tonsils of consumptives show evidence of tuberculosis in the vast majority of cases, though the rest of mouth, nose, and pharynx does not. Dr. A. M. Shrady, with a very long experience at the Seton Hospital for Tuberculosis says it is a rare occurrence for consumptives to develop clinical tuberculosis of the tonsil and that they usually die without clinical signs of infection of neck nodes. On the other hand the infrequency of clinical tonsillar tuberculosis and hitherto the almost uniform failure to demonstrate it microscopically have made some question the etiological importance of the tonsil in cervical tuberculosis. Other avenues of infection are by no means wanting, such as gums, nose, and pharynx, and even the skin of the face, lips, and scalp. In the past ten years we have seen probably 25 cases of tuberculous femoral adenitis result from scratches on the foot. One child under six months of age had a tuberculous inguinal bubo following a scratch with a diaper pin at the base of the penis. These cases are mentioned simply to show that almost any part of the body's surface may admit the bacillus. The writer submits the results of the examination of sixty-five whole tonsils recently removed. These can be considered in three groups:

1. *Fifty-seven tonsils removed for a variety of reasons from children and embracing all types of tonsils.* In none of these patients was there reason to suspect tuberculosis in the neck or other part of the body. None showed tuberculosis on microscopic examination in the tonsil, *i.e.*, there was no accidental discovery of tubercle in a tonsil where it was not suspected. This confirms the experience of others. Hodenpyl examined several hundred tonsils without finding any tuberculous. Hurd quotes Wright as having examined 60 unselected specimens without finding tubercle. Judd, of Rochester, says that at the Mayo's Clinic only one or two tuberculous tonsils have been found among some hundreds of tonsils sectioned. In conversation one frequently hears it said as a piece of common knowledge that tonsils removed for all causes are found tuberculous in 5 to 10 per cent. of cases. I am unable to find who said it first and feel certain that it does not approximate the truth. With the uniform result of examinations by Hodenpyl, Wright, the Rochester Clinic and myself we feel safe in asserting that one is not likely to find the tonsil harboring the tubercle bacillus without other manifestations of tuberculosis in the body.

2. *Five tonsils showing well-defined tuberculous lesions and all taken from children with recent tuberculous cervical adenitis.*

Case I.—A small collection of nodes at angle of left side of jaw, largest hickory-nut sized. Left tonsil small. In it, several discrete scattered tubercles, few giant cells, just a suspicion of central necrosis. A couple of tubercles located in the capsule of the tonsil.

Case II.—Boy at Sea Breeze Hospital for Tuberculosis. Adenitis has not been operated on. Has widely distributed enlarged nodes in both sides of neck. Tonsils are peppered with discrete miliary tubercles both near mouth surface and capsule. No giant cells or necrosis.

Case III.—Age three years. A collar of enlarged nodes in both sides of neck. Seem recent. Von Pirquet positive. Tonsil quite small. Small area in one tonsil shows giant cells with peripheral nuclei and poorly defined epithelioid tubercles. After removal of tonsils the glandular enlargement partly subsided and child removed from hospital without operation upon the neck.

Case IV.—Already reported in Annals of Surgery, April, 1910, p. 577. The enlargement of neck nodes followed a tonsillotomy. Discrete typical miliary tubercles found in tonsillar stumps.

Case V.—Child, age eight years. A few soft glands at angle of jaw found to be tuberculous. The tonsil on the same side as the nodes showed many typical miliary tubercles. The enlargement of nodes was recent.

### 3. *Cases with tuberculous glands in neck but without tuberculosis in tonsil.*

Case VI.—Child, age three. Glands in right side of neck of one month duration. Von Pirquet positive. The largest node is the tonsillar one, but the first one to enlarge was in front of the submaxillary salivary gland and it was the only gland at operation which had gone to the stage of suppuration. Tonsils, small, appear normal and no tuberculous lesions found in them. In this case it would seem likely from location of swelling that infection took place through lip, gum, or floor of the mouth.

Case VII.—Child. Tonsillar nodes enlarged. Also a large soft node in the substance of the parotid gland just in front of external auditory canal. Von Pirquet positive. Nodes proved tuberculous. Tonsil without tuberculosis. The clinical evidence would suggest that this was a case of scalp infection as the most advanced tuberculous lesion was in a node well up in the parotid gland.

Case VIII.—Two good-sized tonsils not found to be tuberculous. Von Pirquet positive. A collection of nodes in right tonsillar group of several months' standing proved to be tuberculous. In this case clinical evidence suggested tonsillar origin.

As illustrating the probability with which we can infer the point of infection from the location of the first involved node, we may mention the following case: A child, aged four, had tuberculous nodes on the right side in the tonsillar and submaxillary region. A submaxillary node was suppurating. There was a red spot on the upper gum, at the insertion of the second incisor tooth, about one-fourth inch in diameter. This little piece of gum was removed at the same time as the nodes and showed typical tuberculous lesions. This is the only case in which we have demonstrated a tuberculous gingivitis as the starting point for tuberculous adenitis. In this case the tonsils appeared normal and were not removed.

There is an impression that the tubercle bacillus may penetrate the tonsil without producing any manifestations of its presence and be carried through it to the neck nodes. So far as I know, the only basis for the belief is one experiment by Wood of Philadelphia on a pig. He rubbed tubercle bacilli on the tonsil, killed the pig later and identified bacilli in the cervical glands only—not in the tonsil.

To sum up, 57 tonsils of patients not clinically tuberculous show no tuberculous lesions. Of 8 patients with cervical adenitis the tonsils are tuberculous in five. In two there is evidence of other than tonsillar origin for the infection. In one the adenitis was of long standing and may have been extratonsillar in origin or slight tonsillar lesions may have escaped observation.

These results closely parallel those of Hurd. In an examination of 11 tonsils from patients with tuberculous nodes he found tuberculosis in the tonsil 8 times. In an examination of 13 tonsils of persons with slightly enlarged neck nodes, not believed from clinical evidence to be tuberculous, only one tonsil showed tubercle. In cases then where there is clinical evidence that the tonsil is responsible for a tuberculous adenitis, both Hurd and myself have as a rule found tuberculous lesions in the tonsil.

### CHARACTER OF TONSILLAR TUBERCULOSIS.

Hurd has said that tuberculosis is to be found in the small buried tonsils, not the large soft elevated ones. We may put it in another way and say tuberculosis does not greatly enlarge the tonsil. In none of our five have the tonsils been considerably enlarged. The lesions as seen by the microscope have shown considerable variation in type. For instance, giant cells are in some few, in others abundant. In general we may say that the lesions are scattered rather than confluent, ulceration was never present and there was never more than a suggestion of central necrosis. In other words, we see the early or cellular type of lesion rather than the late fibrous and necrotic. The tubercles have been found both superficial and deep—in one case even in the capsule.

With a recognition of the frequency of tonsillar infection we shall probably more frequently remove the tonsil in cases of cervical adenitis than has been done in the past with the idea of avoiding reinfection of neck nodes. That we have been able to cure so large a per cent. of gland cases without removing the tonsil is simply another illustration, if one be needed, that we do not cure surgical tuberculosis by removing every single bacillus and lesion but by reducing the load of infection with which the body must contend.

If the tonsils and nodes are both to be removed, it would not seem wise to attempt both at one sitting. Which shall be done first will probably have to be decided on the merits of each case. We have seen the nodes largely subside on removal of the tonsils alone; in other cases the extensive involvement of such nodes makes their removal much more important than that of the tonsil.

The material for this paper has mainly come from St. Mary's Hospital for Children. The pathological work has been done at the Laboratory of Surgical Pathology of Columbia University through the kindness of Dr. W. C. Clarke.

# TREATMENT OF TUBERCULOUS GLANDS OF THE NECK.*

A STUDY OF 649 OPERATED CASES.

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TREATMENT of tuberculous glands of the neck by excision dates from the time of Galen, although the first systematic dissections were probably done by Billroth in 1870 and by Rushton Parker and others in 1871.

Formerly, glandular tuberculosis of the neck was supposed to be an expression of general glandular infection, and it was believed that the infection travelled upward from a focus at some point inside the chest. Until the appearance of the comparatively recent study of the anatomy of the lymphatic system by Sappy, Leaf, Poirier, and Cuneo, our knowledge of the source of infection and the avenues travelled by it was very meagre.

There are approximately 800 glands in the entire human body, and nearly 300 of these lie within the tissues of the neck. The glands in this region are the first to appear in the embryo. Placed at the juncture of the head and neck are several groups of glands forming a kind of "glandular collar." This collar is composed of:

1. Suboccipital group, whose afferent vessels drain the occipital portion of the scalp; and efferent vessels which pass to the substernomastoid glands.

2. Mastoid group, which is composed of two or three glands receiving drainage from the temporal region of the scalp and ear, and with efferent vessels to the substernomastoid glands.

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* Read before the Section on Surgery, New York Academy of Medicine, May 19, 1910.

3. Parotid glands. These glands are again divided into several groups lying in different relations to the parotid salivary gland. There are from ten to twenty glands in this group; some lying superficially, some within the parotid, and a separate group lying between the parotid and pharynx. The afferent vessels to these glands come from the anterior part of the scalp, ear, eyelids, root of the nose, nasal fossa, and pharynx, and the efferent vessels pass into the deep cervical chain.

4. The submaxillary glands, three to six in number, lie along the lower border of the submaxillary bone. This group drains the upper and lower lip, cheek, nose, side of the tongue, and gums, and empties into the deep cervical chain.

5. Submental glands; a small group lying between the anterior bellies of the digastric muscles receiving afferents from the lower lip, floor of the mouth, and tip of the tongue, and sending efferents to the submaxillary glands.

6. Retropharyngeal glands. These glands receive vessels from the nasopharynx and drain to the deep cervical chain.

It will be seen that this glandular collar, composed of the six groups of glands, drains the entire scalp, skin, and mucous membrane of the head and face, and that each group sends its drainage to the deep cervical chain. There are no lymphatic vessels passing upward or communicating at any point within the skull.

The descending cervical chain, composed of the glands lying anterior and posterior to the internal jugular vein, and also of those lying in the supraclavicular region together with the secondary groups, may best be considered in a pathologic or surgical sense as one large group. The deep groups are each made up of a number of large glands. In the upper half of the neck they lie almost entirely behind the sternomastoid muscle, while in the lower division they lie opposite the posterior border and in the supraclavicular triangle. The chain extends from the tip of the mastoid process to the juncture of the internal jugular and subclavian veins. The afferent vessels to this chain are those coming from the groups making up the cervical collar, and also several vessels passing directly to the deep glands from the scalp, tongue, palate, œsophagus, and thyroid. The vessels leading from these groups (deep chain-subclavicular-supraclavicular) unite on either side of the neck into one or two large lymphatic vessels called the *jugular trunks;* and these in turn empty on the right side into the internal jugular or subclavian veins, and on the left side directly into the thoracic chyle duct.

The glandular system in the neck terminates on either side in these large lymphatic vessels and has no direct communication with the lymphatic system in the thorax. Poirier and Cuneo, speaking of the afferent vessels of the supraclavicular group, say: "On the other hand these glands receive no vessels coming from the mediastinal glands. Cases of adenitis following mediastinal or abdominal neoplasms can only be explained by a retrograde thrombosis of the afferent vessels of these supraclavicular glands."

To me it seems very important that we should appreciate this point. A great deal of the incomplete and half-hearted work done in removing these glands has been due to the conviction that the diseased condition extended down into the mediastinal glands. From a more thorough study of the anatomy of this region, we now know that direct extension from the cervical glands into the mediastinal glands is impossible, and, therefore, that inflammations and neoplasms affecting the cervical lymphatics are *local* until they pass into the general circulation.

It is a fact generally accepted that the best treatment of accessible, tuberculous lesions, when they are still local, is that of excision. We know that in cases of tuberculosis of one kidney a very high percentage can be cured by removal. A similar process in almost any of the abdominal viscera, if diagnosed before too extensive, can be excised, and in the large majority of instances no further trouble will occur. The same is true of tuberculosis of the joints, epididymis, etc.

We are seldom able to positively demonstrate the exact avenue of the infection. Occasionally we may find the bacilli in a decayed tooth, tonsil, or lupus area, but more often the point of invasion cannot be found. It has been shown, experimentally, that cultures of tubercle bacilli swabbed over the surface of the tonsil may leave no trace of their passing through that organ, but will invade the glands draining the tonsil. In our cases we were seldom able to trace back to the source of entrance. Examination of several hundred tonsils showed tubercles in much less than 1 per cent. In 1000 cases, 2.3 per cent. had positive tuberculous lesions.

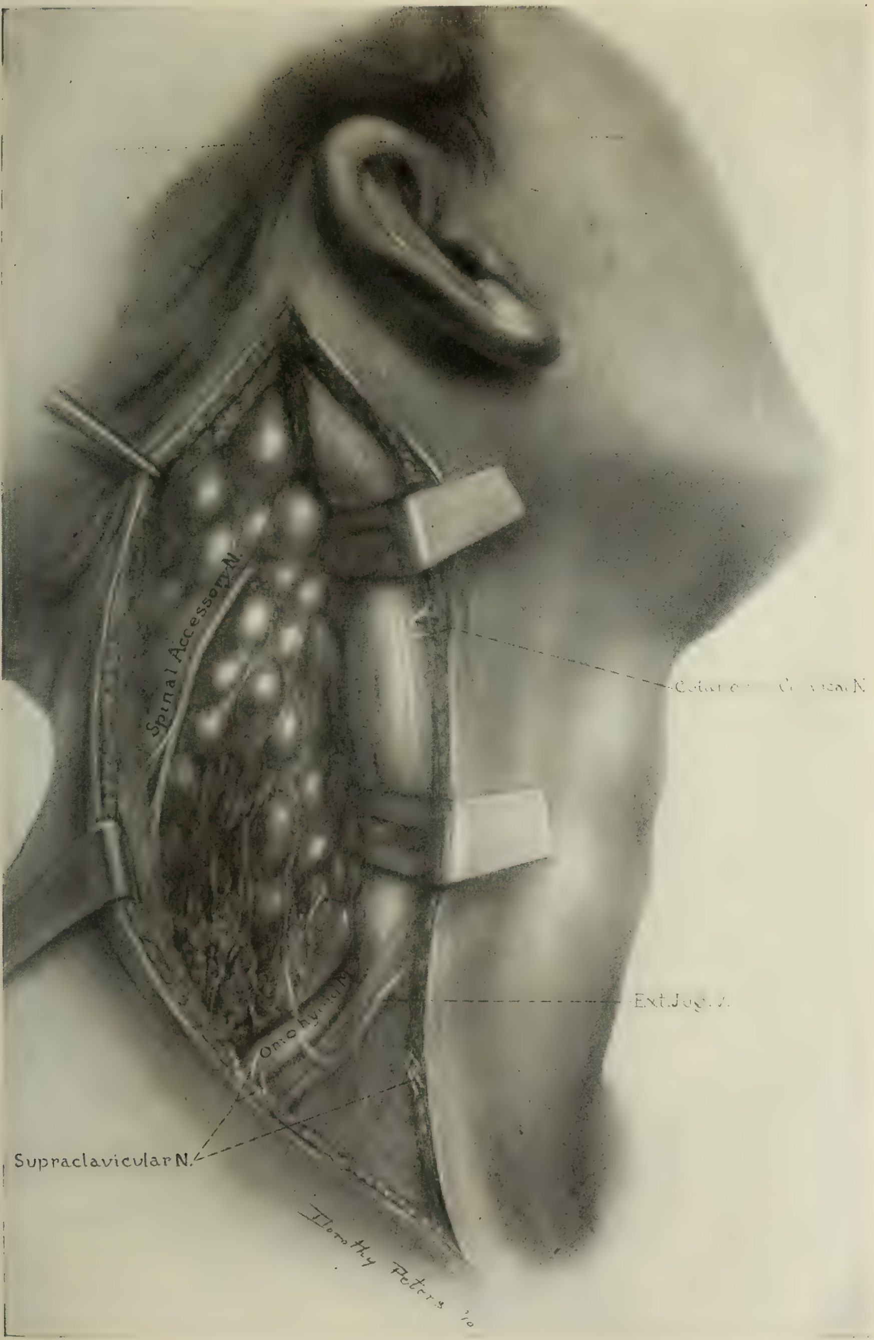
From the histories of our cases of tuberculous glands, we find that in 80 per cent. the first enlargement was beneath the upper end of the sternomastoid muscle; in 18 per cent. the first noticeable enlargement was in the submaxillary, submental, or parotid regions. In four cases the first cervical gland to enlarge was in the supraclavicular group. In each of these four cases the axillary glands were also involved; the infection having presumably entered through an abrasion of the finger or hand. Several cases followed closely upon suppurating otitis media.

*Indications for Operation.*—If we were to make a routine examination of a great number of children between the ages of four and ten, we would find in the majority of them varying degrees of enlargement of the glands. The pathologic changes in these glands, formerly called *scrofulous,* are in part simple hyperplasia, in part tuberculosis. There is no differential diagnostic criterion of the initial stage of glandular tuberculosis. The tissues in these glands predispose and invite tuberculous infection. In this particular type of case our method of treatment has been as follows: First clear the throat of adenoid tissues and tonsils and give such attention as is necessary to the teeth and nose. Assisted by tonics, especially syrup of the iodide of iron, and with out-door living, this treatment has been sufficient to cure most of these cases. The cases that have been perfectly cured seem to be of the hyperplastic type, or, at least, to have been only to a slight degree invaded by the tubercle bacillus. We have occasionally seen a child with caseating nodes. Such cases require, in addition to the above treatment, removal of the infected nodes and drainage. If the glands still continue to enlarge and other glands become involved, it will be necessary to do a complete excision to effect a cure. Most of the patients upon whom we have done a complete excision of the glands have been over fifteen years of age; 18 in 649 cases were under ten years. In the presence of a discharging sinus, it does not appear advisable to excise the glands; we have usually curetted and treated by swabbing with equal parts of tincture of iodine and carbolic acid. As soon as the sinus heals, a radical operation can safely be done if necessary.

Pulmonary invasion is not necessarily a contraindication to operation upon tuberculous glands of the neck. In ten instances we have operated upon patients who showed tubercle bacilli in the sputum. Nine of them were greatly improved and several of them were apparently cured by the operation. One developed an acute diffuse tuberculosis after the operation.

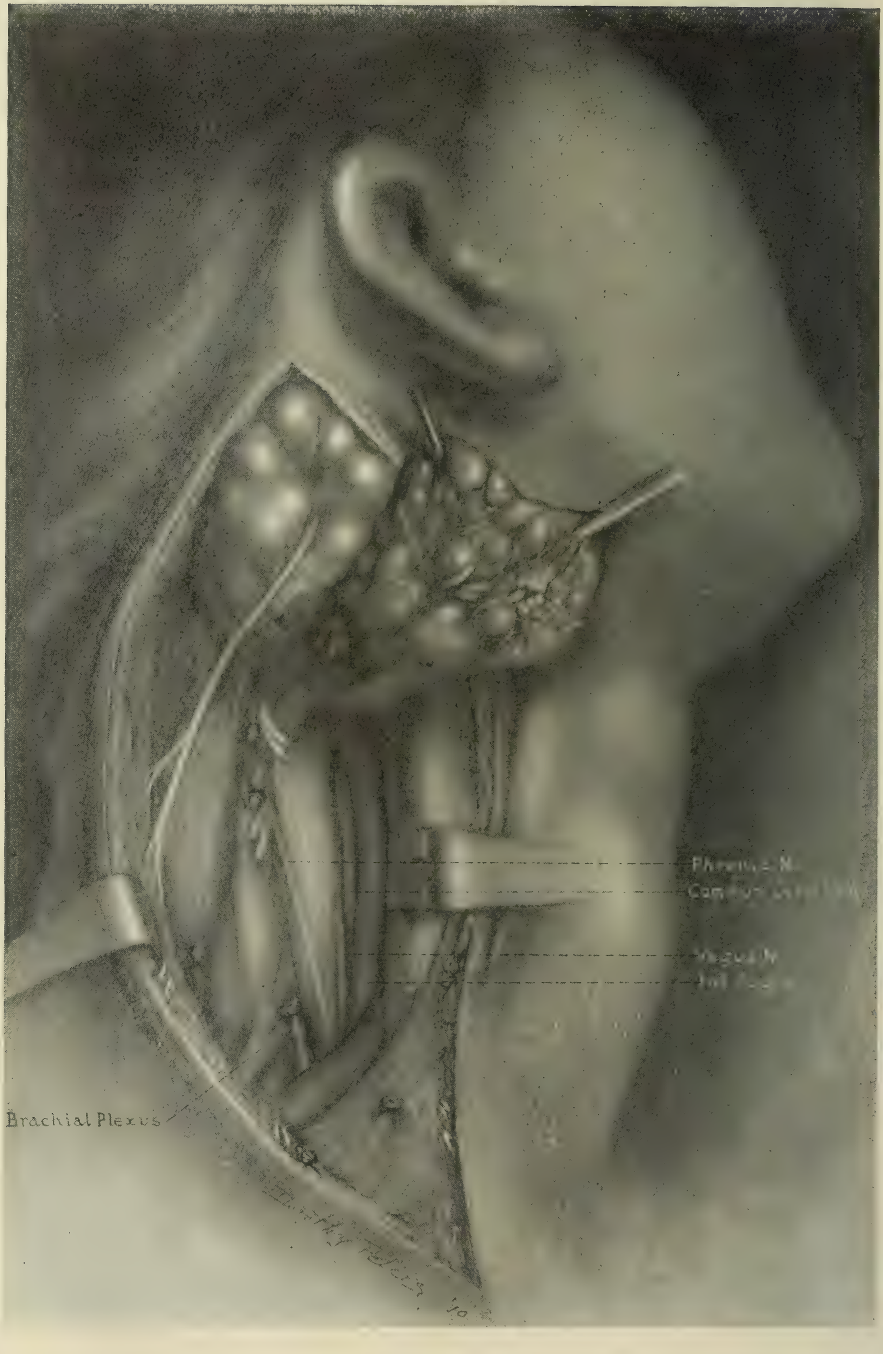
The chief objection to radical excision of glands of the neck is the resulting scar. Various incisions have been described and used. At one time the removal of the glands through many separate incisions was recommended. We have found that if we follow the natural creases in the neck and keep the incision as nearly as possible transverse, as suggested by Dowd, we can remove the gland-bearing fascia in one piece with very little scar or deformity resulting. The incision begins a little below and behind the mastoid process, extends straight down along the outer edge of the trapezius muscle, and then curves forward a little below the middle of the neck, and terminates at the juncture of the sternomastoid muscle and clavicle. Through this incision we are able to remove all of the deep descending chain, including the supraclavicular, the anterior, and the posterior groups. If the submaxillary and the submental groups are involved, a second incision running parallel to the lower jaw, two finger breadths below the lower border, will expose the areas and avoid any important structures, *e.g.*, the lower branches of the seventh nerve. In order to prevent the formation of a wide, ugly scar, it is very essential that we turn back the platysma muscle and the skin

FIG. 1.



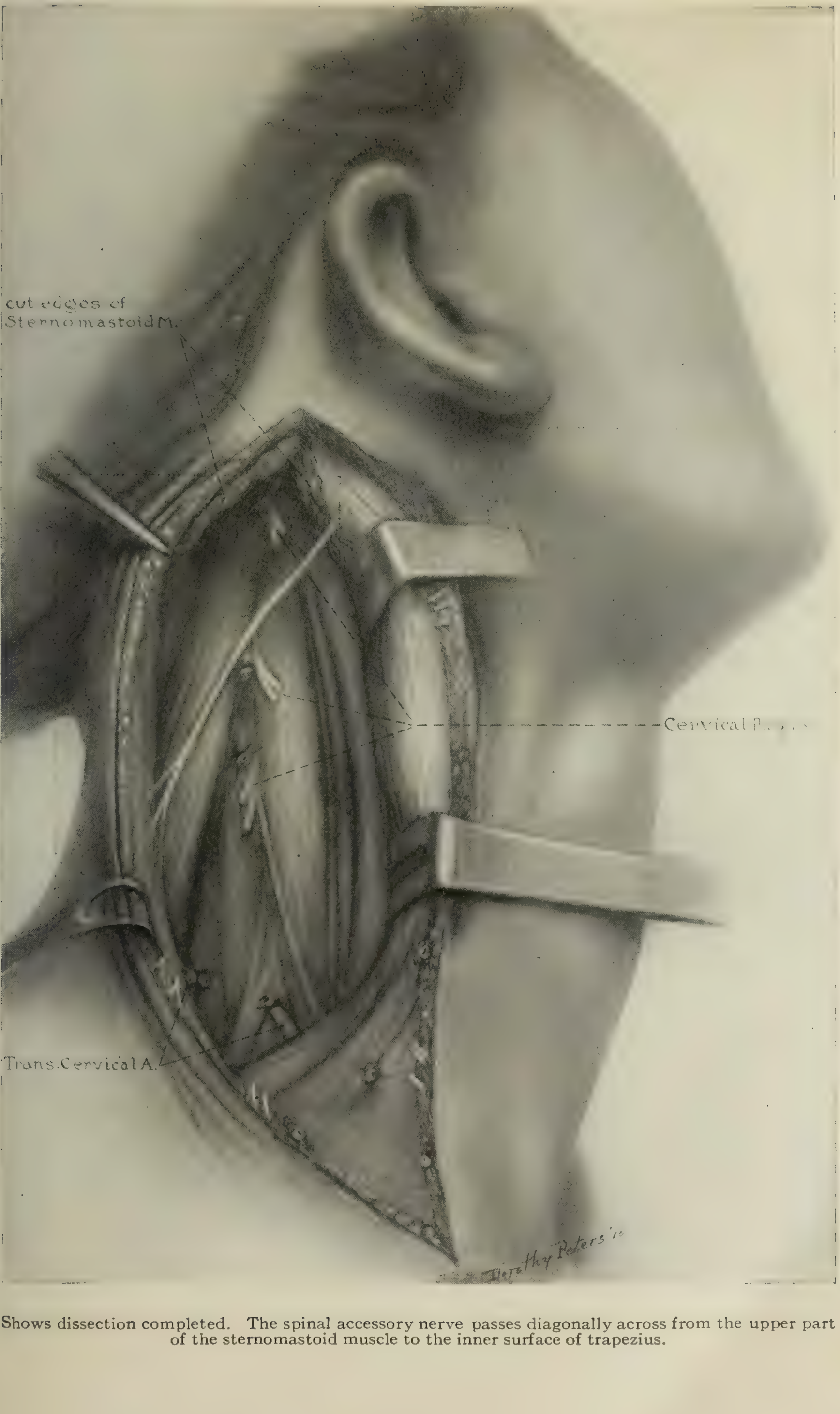
Showing the skin and platysma dissected forward and backward. Retractors under posterior border of sternomastoid, exposing glands lying in gland-bearing fascia. The omohyoid marks the lower angle of the dissection, and the mastoid process, the upper. The spinal accessory nerve is partly dissected from among the glands.

FIG. 2.



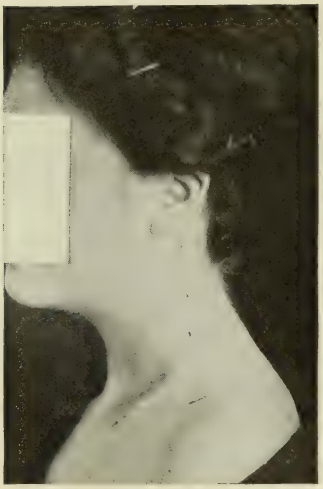
Showing fascia dissected from the lower angle. Internal jugular vein shown lying beneath the sternomastoid muscle. The phrenic nerve, lying on the scalenus anticus muscle and branching from the cervical plexus, is exposed.

FIG. 3.



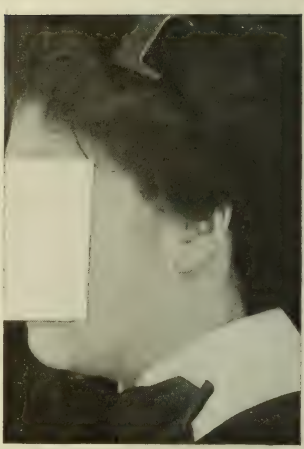
Shows dissection completed. The spinal accessory nerve passes diagonally across from the upper part of the sternomastoid muscle to the inner surface of trapezius.

Fig. 4.



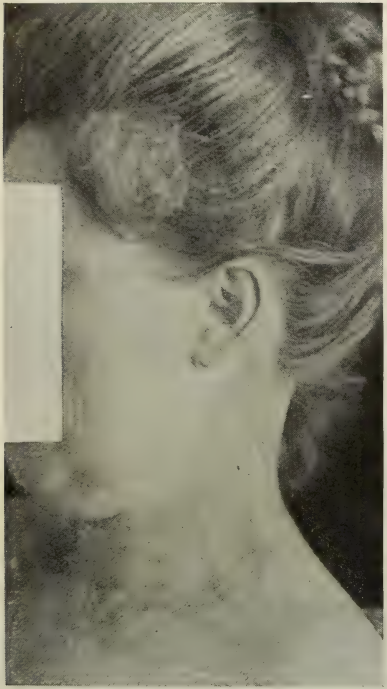
Photograph taken nine days after operation.

Fig. 5.



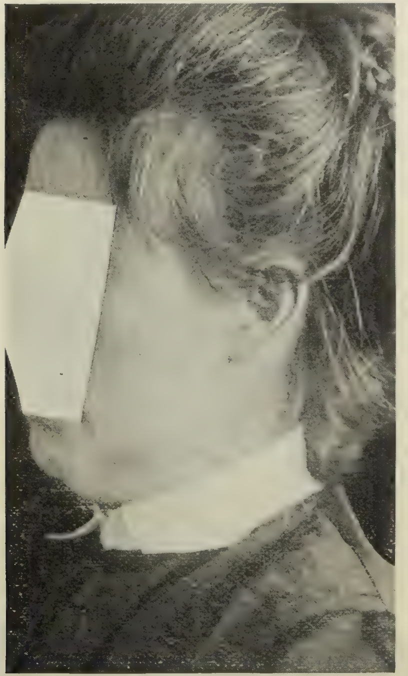
Photograph taken nine days after operation.

Fig. 6.



Photograph taken about two years after operation.

Fig. 7.



Photograph taken about two years after operation.

Fig. 8.

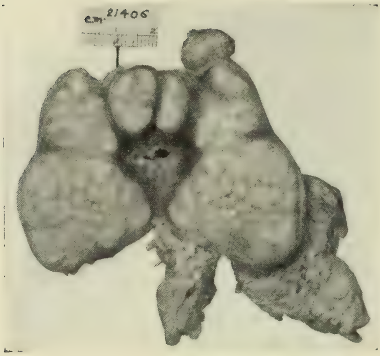


Fig. 9.

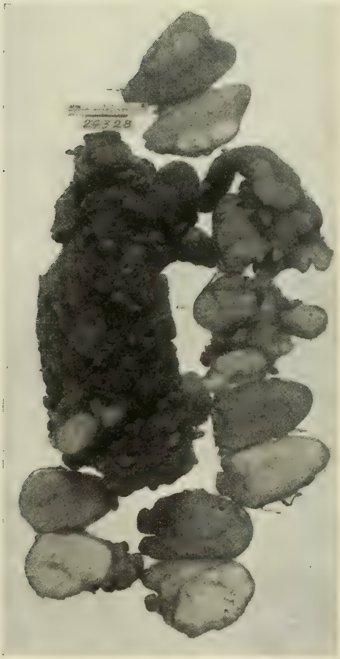
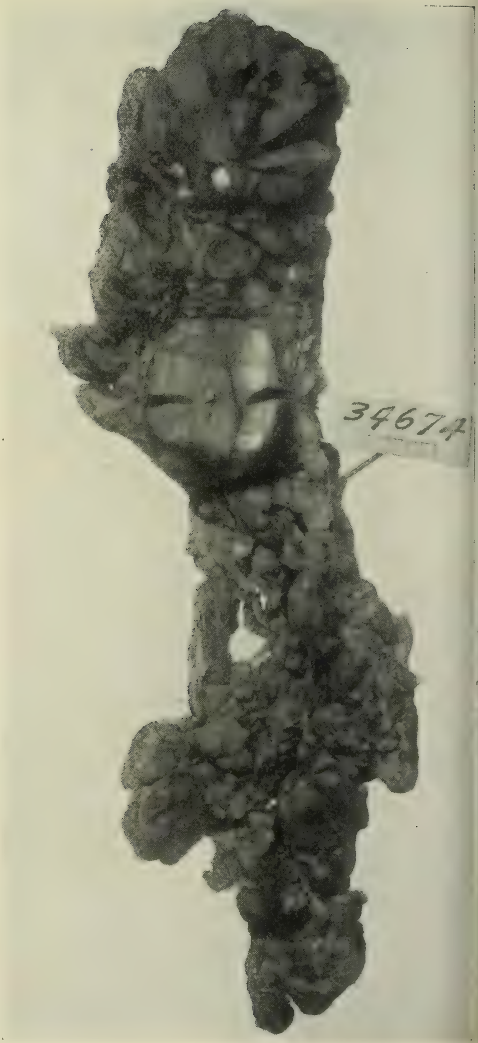


Fig. 10.



Figs. 8–10.—Photographs of tuberculous glands after excision.

Fig. 11.

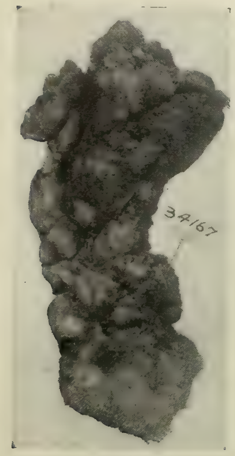


Fig. 12.

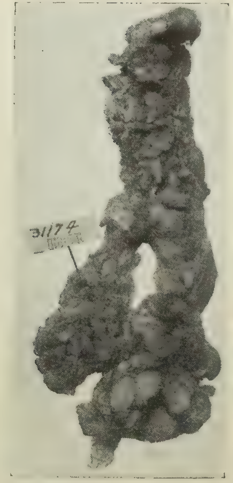
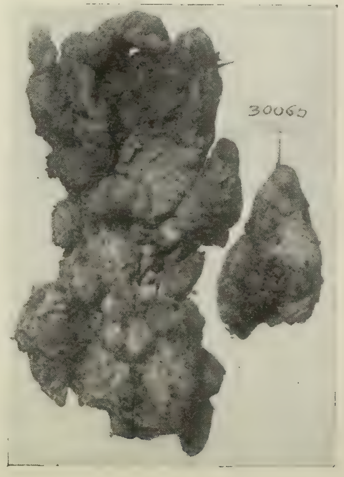


Fig. 13.



Figs. 11-13.—Photographs of tuberculous glands after excision.

in each flap. It is also important that the cut edges in the platysma muscle be sewed together before closing the skin. If these cut edges are allowed to retract, the separation will favor the division of the skin scar. In the past it has not been unusual to see a scar on the neck half an inch to one inch in width (Figs 4 and 5).

It is our custom to drain these cases through a stab incision; this allows the large incision to heal primarily, and we believe this procedure of valuable aid in getting a good scar. The spinal accessory nerve is the only superficial structure that it is necessary to avoid in operating. In many cases the first gland to break down will be the one beneath the spinal accessory as it comes out of the sternomastoid muscle. In several instances we have known the nerve to be cut by simply lancing this broken-down gland. Usually the nerve will be readily found coming out of the sternomastoid muscle one-half inch above the superficial sensory nerves, or it may be identified as it passes into the outer border of the trapezius at the top of the supraclavicular triangle (Fig. 1). If the nerve is accidentally cut it can be sutured at once. It will unite and generally functionate well. If the ends of the nerve are allowed to retract, the deformity will cause a drooping shoulder and an atrophy of the trapezius muscle, which is unsightly and also hampers the use of the arm and shoulder to a considerable degree. We have injured and sutured this nerve on several occasions with no deformity resulting.

In a study of the anatomy of the lymphatics, we observe that tuberculosis invading these glands is likely to be a local process and not an indication of general infection. The entire chain of glands beginning at the subclavian vein and running back to the mastoid process can be removed in one piece without injuring a single important structure. If we consider the glands lying in the cellulo-adipose tissue (gland-bearing fascia) in the neck as a single organ, and treat the mass in a manner similar to that employed in tuberculosis of other organs, our results will be just as good and we will have done as much for the patient as though we had taken out a tuberculous kidney or removed a tuberculous cæcum.

Some years ago it was customary to expect all tuberculous glands to recur. Lymphatic glands and vessels are anatomical structures, and if they are removed we believe are no more likely to recur than a finger is likely to regenerate after it has been amputated. Leaf is alone, I think, in believing that a lymphatic gland will redevelop between the two open ends of lymphatic vessels. In our own cases, we are convinced that the glands which appeared after operation were glands which had not been removed.

During the past fifteen years we have performed 668 operations for complete excision of glands of the neck, 62 operations for partial excisions and curetting, and 24 excisions of tuberculous glands in the axilla in cases which also had tuberculous cervical glands. In all there were 649 patients operated upon on one side at a time. Of these, 19 have since died of pulmonary tuberculosis, and 9 have died of tuberculous lesions elsewhere. Ten of the patients had pulmonary tuberculosis at the time of operation.

In operating upon these cases, it has been our effort to do a radical and thorough excision of the groups involved. Having made the incision from the mastoid to the clavicle, we reflect the skin and platysma well forward and backward. We do not cut the sternomastoid, except a few posterior fibres of its upper attachment on the mastoid process. The entire posterior border of this muscle is freed and the fascia dissected from it. The dissection is started at the lower angle underneath the clavicular attachment. The omohyoid pulley is exposed and this is the lowest point of the dissection. The glands are all left together in the fascia as much as possible (Fig. 2). In some cases the gland-bearing fascia can be dissected with gauze or the finger; at other times, especially if the X-ray has previously been employed, or if considerable resistance has developed, the dense fibrous tissue will necessitate sharp dissection. In freeing the edge of the sternomastoid muscle from below, up about half way we come to the superficial cervical nerves, some of the branches of which turn over and across the muscle. These are purely sensory nerves and it is best to sever them and get a good exposure. A numbness which persists for some time occurs after cutting these nerves. One-half to one inch above the sensory nerves the spinal accessory emerges from the sternomastoid muscle and passes obliquely downward and outward superficially through the fascia to the trapezius. In carrying the fascia upward, we should, if possible, save the cervical fascia covering the brachial plexus. Traumatism of this plexus will frequently cause considerable suffering. The thoracic chyle duct as it enters the vein should be avoided. It is not uncommon to see the chyle duct on the right side. We have injured this duct during operation in about ten cases; in several instances it healed without causing trouble. In three cases the chyle drained profusely for several weeks and the patients became greatly emaciated. One of them lost 60 pounds; the duct eventually closed, however. All the patients made a good recovery. When the spinal accessory nerve is encountered, it should be dissected free from the fascia and held back while the fascia and glands are turned underneath it. As soon as the internal jugular vein is exposed, it is best to partially occlude its lumen in the lower angle by a gauze pack. This will keep the vein full and prevent sucking of air in case the vein is torn. On several occasions we have heard air sucking into the vein, but have seen no bad results from it. The dissection along the entire jugular vein is sometimes tedious, but we have sacrificed the vein in tuberculous cases in only two instances. Some care should be taken to avoid the phrenic nerve lying on the anterior scalenus muscle. The fascia will lead us directly to the styloid and mastoid. Lymphatic glands within the parotid should be shelled out in a manner that will not interfere in any way with the branches of the seventh nerve. Having completed the dissection, if caseous material has soiled the wound, we mop it out with tincture of iodine well diluted with water; or as suggested by Von Eiselsberg, the entire wound may be mopped for an instant with boiling water. We have never seen any sort of an infection following the spilling of caseous material on the fasciæ (Fig. 3).

Drainage should be provided through a stab incision; we use, preferably, a small rubber tube split spirally. This drain is for the purpose of withdrawing serum and is removed in from 24 to 48 hours. The platysma muscle is carefully sutured with fine catgut, and the skin edges approximated by a subcuticular suture approximating as much of the cut of the skin as possible, giving the appearance of a ridge. In a few days this will smooth down to a line-scar (Figs. 6 and 7). A rather small, snugly fitting gauze dressing is used. The next day the patient is gotten up and encouraged to move the head freely to prevent any stiffening of the muscles. From this time general out-door treatment is advised.

In our series of cases we have had no mortality due directly to the operation. One patient died a few weeks after operation of general tuberculosis, and a second died in about three months from diffuse sepsis (Figs. 8 to 13).

### TABLE OF CASES.

| | |
|---|---|
| Total number of patients operated upon | 649 |
| Total number of operations | 750 |
| Average age | 25 |
| Number of cases under 10 years of age | 18 |
| Complete excisions | 668 |
| Curetted | 62 |
| Both sides operated upon | 94 |
| Recurrence in region of former operation (8.6 per cent.) | 56 |
| Died of pulmonary tuberculosis (5 per cent.) | 19 |
| Mortality (1 died in 4 weeks, 1 in 3 months, 4 in 1 year, 5 in 2 years, 2 in 3 years, 2 in 4 years, 1 in 5 years, 2 in 6 years, 1 in 8 years) | 19 |
| Died of tuberculous lesions other than pulmonary | 9 |
| Mortality (2 meningitis, 5 diffuse tuberculosis, 2 tuberculous peritonitis) | 9 |
| Died of other trouble | 14 |
| Number of patients with pulmonary tuberculosis at time of operation | 10 |

# METALLIC FOREIGN BODIES IN A BRONCHUS.*

## WITH A REPORT OF TWO CASES.

BY GEORGE RYERSON FOWLER, M.D.,
OF BROOKLYN, NEW YORK.

THE distressing symptoms accompanying and following accidental inspiration of foreign bodies and the changes arising from their presence in the air-passages stamp this class of cases as extremely grave in character, and hence of the greatest importance to the surgeon.

In the early history of the subject it is to be noted that a prejudice existed against the performance of the operation of tracheotomy, through fear that the cartilages would not reunite, and it is to be presumed that many victims to these accidents perished in the early days who might have been saved by a prompt incision of the tracheal rings, an operation which, at the present day, is indicated not only in cases of lodgement of a solid foreign body in the upper air-passages, but also those in which it is situated low down in the respiratory tract.

Metallic foreign bodies in the bronchi form a class by themselves. The advances in methods of diagnosis of metallic foreign bodies in the organism in general made in recent years suggest this classification. The certainty with which the X-rays make the identification of metallic foreign bodies in general possible, and the ease with which the X-ray diagnosis may be verified in the case of those situated in the bronchi by instruments constructed on the principle of the telephonic probe of Girdner constitute a marked advance in the surgery of foreign bodies.

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* Read before the New York Surgical Society, Dec. 13, 1905.

EDITOR'S NOTE.—This contribution was found among the manuscripts of the late George Ryerson Fowler and, never having appeared in print, is sent for publication by his sons, Dr. Russell S. Fowler and Dr. Royale H. Fowler.

The question of the point of final lodgement of foreign bodies in the bronchi is of interest in this connection, and here two divisions must be made of the subject. For instance, those that are irregular in shape, such as hooks, safety-pins, etc., and which may lodge at various points above the point where the respiratory tube becomes sufficiently narrow to arrest their further progress, as well as coins and similar objects that may lodge either transversely or be placed on edge and either partially or completely occlude the bronchus, form a group separate from those that are regular and smooth in outline and pass directly to a point where their arrest is coincident with complete occlusion of the bronchus and consequent collapse of the lung beyond the point of occlusion. Further, the question of complete or partial occlusion may turn upon other peculiarities of form of the foreign body. For instance, hollow bodies or those that are tube-like in character, with a continuous lumen and an opening at each end, and which, when placed in the long axis of the bronchus do not prevent the passage of air, such as tracheotomy cannulas, form a peculiar group. Finally, there is another class of tubular metallic foreign bodies in a bronchus that have furnished several examples in the literature, namely, those with one end closed. The most familiar of these is the common pencil cap, a device employed to protect the point of a lead-pencil when carried in the pocket.

As between the two primary bronchi it is the general belief that foreign bodies entering the upper air-passages with few exceptions pass into the right bronchus. This has been attributed to, (1) the greater volume of the right bronchus due to the functional inequality of the two lungs, the left having one lobe less to supply with air than the right; (2) the fact, pointed out by Dr. Goodall, of Dublin, that the septum placed at the lower part of the trachea between the two bronchi is situated somewhat to the left of the median line, as a result of which the lumen of the right bronchus is more directly in the line of the axis of the trachea than the left, and a foreign body in its passage from the trachea will, by virtue of the laws of gravity, be directed toward the right bronchus; (3) the force of the current of inspired air is greater on the right than on the left side, owing to the inequality of respiratory function of the two sides, this serving to direct the foreign body to the right (Poulet).

In spite of these anatomic and physiologic reasons why the foreign body should find its point of lodgement in the right bronchus in almost every instance, the fact remains that, according to the most conservative estimate, at least one-third find their way into the left bronchus (Gross, Boudillat, and others). On the other hand, Dr. W. B. Cheadle[1] collected from the English journals 34 cases of foreign body in a bronchus, in 30 of which the position of the foreign body was stated. Of these, in 16 it was lodged in the left bronchus, and in 14 in the right. Adding to this 3 cases coming under his own observation, in all of which lodgement took place in the left bronchus, we have 19 cases in the left to 14 in the right. Although this estimate is based on comparatively few cases, the figures are suggestive, at least, of the frequency of the entry of a foreign body into the left bronchus.

Of metallic foreign bodies of tubular form, those with both ends open, and which permit free entrance and exit of air, give rise to an entirely different train of symptoms when arrested in the bronchus from those present when occlusion of the bronchus takes place. The symptoms caused by the passage of the foreign body through the glottic opening and past the vocal cords differ according to the size of the lumen of the object. When the lumen is small the symptoms are practically the same as when a solid body is present, namely, those of impending suffocation due to energetic contraction of the irritated glottic opening and larynx. When the lumen is large the foreign body resting in the glottic opening or in the larynx becomes practically an intubation tube. Likewise when the foreign body is lodged in a bronchus, the differences are marked in direct proportion to the diminution of the calibre of the tubular object and the freedom with which air passes through the lumen of the latter to and from the corresponding lung. In cases of impaction of detached tracheotomy cannulas in the bronchi, the symptoms may be of so mild a character as to lead to a disbelief on the part of the medical attendant in the patient's statements, as occurred in a case recorded by Clement Lucas. Examination of the chest in this class of cases reveals nothing to call attention to the presence of the foreign body. Resonance persists everywhere, and the respiratory murmur is but slightly if at all interfered with, the air passing into the alveoli comparatively unimpeded. The clinical picture presented in the above class of cases becomes more and more striking in contrast with that which is presented in cases of tubular foreign bodies of lesser calibre in proportion to the obstruction offered by the latter to the free passage of air, until, finally, the lumen may be so small as to convert the object into practically a solid foreign body.

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[1] Medico-Chirurgical Transactions, vol. lxxi, 113.

On the other hand the lodgement of solid foreign bodies in the bronchi gives rise to a train of characteristic symptoms, these being attributable, first, to the suppression of the function of the corresponding lung, second, to changes in the lung tissue due to collapse of the alveoli, and third, to inflammatory septic conditions following the prolonged presence of the foreign body in the bronchus such as acute followed by chronic bronchitis, pulmonary emphysema, and, rarely, by ulceration of the wall of the latter. Escape of the foreign body into the surrounding lung structure may or may not follow ulceration of the wall of the bronchus, but in any event, with the occurrence of the latter septic pneumonia follows, terminating in abscess or gangrene. The prolonged presence of a foreign body, whether tubular or solid, or partially or completely occlusive, in a bronchus without giving rise to grave symptoms is one of the rarest occurrences in surgical experience.

In connection with the question of calibre it is to be remarked that foreign bodies that obstruct the right bronchus are much more dangerous than those that obstruct the left, for the reason that a much larger respiratory area is compromised. Further, sudden, complete, and permanent occlusion of either primary bronchus is apt to prove fatal early in the case, for the reason that compensatory action on the part of the other lung cannot be established with sufficient promptness to prolong life.

The following instances of metallic foreign body in a bronchus are brought forward as contributions to the literature of the subject. The special interesting features of the cases relate, first, to the fact that in one of them, as in the case of Clement Lucas, scarcely any symptoms were present to support the patient's assertion that his tracheotomy tube had slipped away and passed " down somewhere " as he stated it, that the case antedated the use of the Röntgen rays in surgery, and therefore the presence of the foreign body was only discoverable by the aid of the telephone probe, and that this accident occurred to the same patient upon a second occasion, with precisely the same absence of symptoms, was identified in the same manner, and removed by the same means. In the other case the presence of the foreign body in the bronchus, likewise metallic and tubular in character, but with one end closed, gave rise to the most pronounced symptoms. In the second case the diagnosis, made by Dr. Linder who was called to see the boy in consultation with the family physician, was verified by the X-rays, and in both cases the steps taken for the removal of the foreign body were greatly facilitated and made both certain and safe by the employment of forceps connected with the telephone receiver in the manner employed in the use of the telephonic probe of Girdner.

Case I.—Methodist Episcopal Hospital, No. 2982. J. L., age thirty-five, farm laborer, admitted March 14, 1892. A little over a year previously while in a fit of drunken despondency he had attempted suicide by cutting his throat. He had made a number of slashes, but only succeeded in severing the epiglottis and wounding the neighboring soft parts in several places. Owing to the presence of a large amount of cicatricial tissue following the healing, it had been necessary for him to wear a tracheotomy tube ever since. This was made of aluminum. On the night preceding his admission to the hospital he had retired with the tube intact and in place. Upon awaking in the morning he found the shield part of the tube fastened to the tape about his neck, but the tube itself was missing. He was not conscious of its presence in the air-passages, but supposed it to be there, as he could not account for its absence otherwise.

There was no dyspnœa, no cough, nor other discomfort attributable to the lodgement of the tube in a bronchus. The patient's only anxiety was the fear that he might not recover the tube, and be thereby compelled to purchase another. An examination of the chest organs was negative.

A telephonic probe was improvised by means of the ordinary Bell receiver of the telephone system, a sound gauge served as a large metallic electrode, a long silver probe of the common pattern, and a pair of conducting cords from the battery in the ward completed the apparatus. The circuit through the telephone was completed by moistening the plate with a solution of common salt and pressing it firmly against the surface of the chest wall.

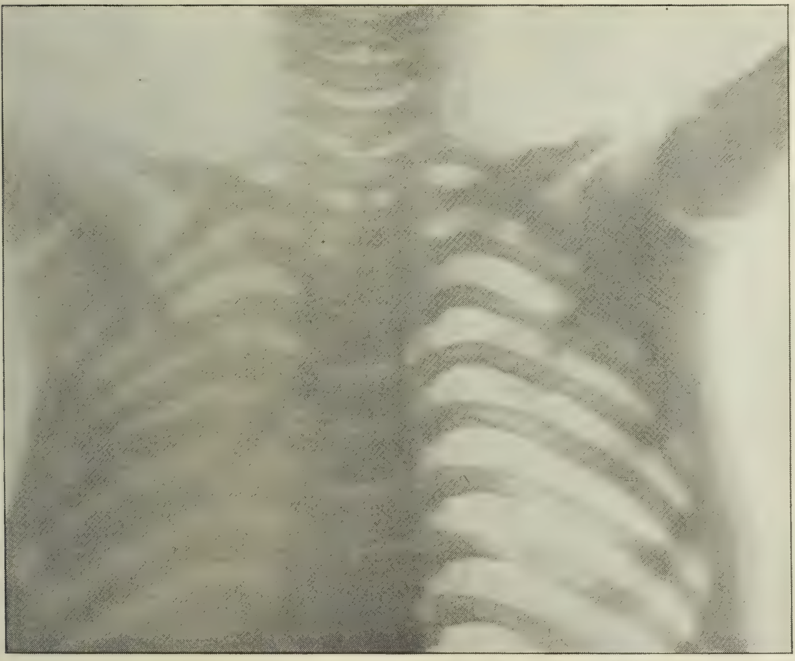
An opening was made in the trachea as low as possible, and with the edges retracted the improvised telephonic probe was passed, first, into the right bronchus, but without encountering the tube. It was then slightly bent at its extremity and again introduced, and directed this time toward the left bronchus. The characteristic grating sound heard in the receiver held to my ear by an assistant showed that the probe was passing over the inner surface of the lost tracheotomy tube.

The probe was then withdrawn and a flexible throat forceps substituted for it in the telephonic circuit. This was then introduced in the direction of the left bronchus. The same grating sound announced its contact with the tracheotomy tube. When the distance travelled by the passage of the forceps was judged to be a half inch greater than the length of the tube, the jaws of the forceps, which up to this time had been closed and partially concealed in the flexible shank of the instrument, were projected and opened, and the forceps withdrawn with the tracheotomy tube strung onto its stem.

The low tracheotomy wound was allowed to heal and the patient was discharged wearing a silver tracheotomy cannula, which he was advised to watch carefully that it did not become loosened from the shield.

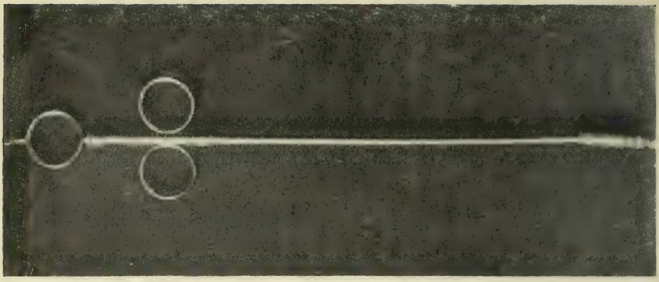
In spite of the warning given, and his past experience as

FIG. 1.



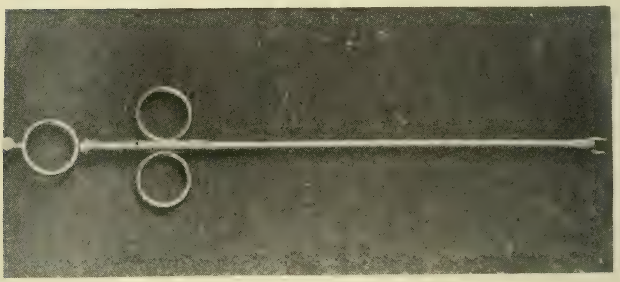
X-ray photograph showing pencil top in left bronchus.

Fig. 2.



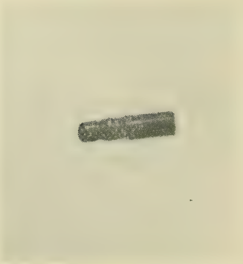
Modified Wells bullet forceps in telephonic circuit, grasping the foreign body.

Fig. 3.



Modified Wells bullet forceps, prongs partly open.

Fig. 4.



Lead pencil cap removed from bronchus.

well, he again applied for admission to the hospital three and a half years later (October 3, 1895, Hospital Case No. 6281) with the same story of having "swallowed" the tube. On this occasion, however, he was awake when the accident occurred, and was stooping over washing his face when he felt the tube detach itself from the cannula. There was a momentary sense as of something slipping down, but that was all.

The same steps were taken to identify and recover the tube as on the first occasion, and with the same success. When discharged from the hospital on this occasion he was provided with a hard rubber tube, since which time he seems to have had no further trouble.

Case II.—German Hospital, Brooklyn, Hospital Case No. 7963. W. M., age eleven, school boy, admitted November 6, 1905. Six days before admission, while sucking a metal pencil cap the latter slipped past the back of his tongue. He was seized with a violent fit of coughing and severe dyspnœa. His parents hurried him to a hospital in the neighborhood, where he was given a glass of water to drink. He immediately said that he felt better, and that the pencil cap had gone down, meaning that he had swallowed it. On his return home, however, he continued to have paroxysms of coughing, during which he became very cyanotic.

He was seen at this time by Dr. Linder, who noted labored breathing, the accessory respiratory muscles being called into play, and marked retraction of the left anterior chest wall on inspiration. Percussion showed dulness, amounting almost to flatness, on the left side. Auscultation revealed absence of breath sounds over the retracted area and diminished breathing over the upper left chest. There was tubular breathing over the upper lobe of the right lung. The heart's action was rapid and tumultuous.

A fluoroscopic examination was made and the foreign body found to be situated on the left side and lying in an oblique direction, corresponding to the left bronchus. Its centre apparently rested opposite the sixth rib. Judging from the relations that it bore to the available landmarks of the bony chest wall, and from the fact that some air entered the upper lobe of the left lung, it was estimated that the branch of the left primary bronchus leading to the latter was only partially occluded (Fig. 1).

A duplicate of the pencil cap was procured for the purpose of adapting or constructing an instrument for the removal of the foreign body. The latter was found to be tubular in shape, one and one-half inches long by about a quarter of an inch in diameter, and closed at one end. Near the closed end an ornamental bead had been spun in the metal.

With the aid of Mr. Julius Pfarre, of Tiemann and Company, an instrument was adapted for the removal of the pencil cap embodying the features of flexibility, proper direction of grasp, and a telephonic probe attachment. The instrument known as Wells's bullet forceps was modified for the purpose. The modification consisted in changing the direction of the jaws, so that instead of grasping an object from without as the wire stem within the flexible shank or cannula is pushed forward, as was originally intended, it would grasp a tubular body from within as the stem was withdrawn (Figs. 2 and 3).

On November 8, eight days following the accident, under chloroform, the operation of low tracheotomy was performed, and a half-round section of the tracheal rings on each side of the tracheal wound removed by means of the tracheal chondrotome. The skin on each side of the incision and the corresponding sternohyoid and sternothyroid muscles were sutured together with catgut. This gave ample working room without the necessity for forcible retraction of the edges of the incision. The telephonic forceps was then introduced and directed toward the left primary bronchus. A click followed by a fine grating sound in the receiver at my ear announced that the forceps had entered the tube of the pencil cap. Knowing the shape of the foreign body, no hesitancy was now felt in pushing the instrument onward until its farther progress was arrested by the closed end of the cap. The sliding stem within the cannula-like shank of the instrument was then withdrawn, thus expanding the jaws and engaging these on the inner surface of the tube. Their hold was increased by the presence of the ornamental bead referred to. Once engaged the forceps were slowly withdrawn and with it the pencil cap (Fig. 4).

A tracheotomy tube was placed in position temporarily. This was removed after twenty-four hours, and the wound allowed to close. The collapsed lung slowly expanded, and when examined by Dr. Linder a few days later had practically regained its normal condition.

*Remarks.*—Instances are not wanting in the literature of the detachment of a tracheotomy cannula from its shield and passage into a bronchus. Tubular foreign bodies have been removed by means of a metallic wire curved like a hook. In a case reported by Adler,[2] in which a piece of pipe stem was lodged in the right bronchus of a child of seven, the first attempt at removal resulted in transferring the foreign body to the left bronchus, from which place it was recovered on the following day by the above mentioned device.

A device improvised by Helferich[3] is worthy of mention in this connection. The foreign body, a metal pencil holder, was located in the left bronchus of a child of six, the situation of which was determined by the X-rays. The operator attached a rubber finger cot to a long tube and passed it into the open end of the pencil holder. The finger cot was then inflated and, thus engaging the tubular foreign body, the latter was removed.

In the very interesting case reported by Dr. Cheadle[4] the foreign body, which appears to have been somewhat like the pencil cap herewith reported, was likewise lodged in the left bronchus. In this case, as in my own, the tube had fortunately passed with the closed end first, thus leaving the open end presenting. A low tracheotomy was performed and through the opening thus made the forceps used for removing the intubation tube (O'Dwyer) was introduced. The open end of the tube was engaged by the forceps, the blades of the latter expanded, and thus secured the pencil cap was withdrawn.

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[2] Quoted by Poulet (Treatise on Foreign Bodies), vol. ii, 43.

[3] Zeitschrift für Chirurgie, lxvii.

[4] *Ibid.*

# SARCOMA OF THE CLAVICLE: END-RESULTS FOLLOWING TOTAL EXCISION.*

BY WILLIAM B. COLEY, M.D.,

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Attending Surgeon to the General Memorial Hospital; Attending Surgeon
to the Hospital for Ruptured and Crippled; Professor of
Clinical Surgery, Cornell Medical School.

THE first case of total excision of the clavicle for sarcoma was the famous case of Valentine Mott, operated upon on June 17, 1828, and published in the *American Journal of the Medical Sciences,* 1828, vol. iii, p. 100.

In Mott's case the tumor had been first noticed in February, 1828, and, as in my own case, followed shortly after a strain. The tumor was treated for a considerable time with plasters, poultices, a seton, and escharotics. At the time of operation it was 4 inches in diameter, of "incompressible hardness," and a portion of it was covered with fungous granulations. Mott gives a very detailed description of the operation. He states that "the patient lost some 16 to 20 ounces of blood, that the tumor was about the size of a man's doubled fist. It consisted of a bony cup, was incompressibly hard at all parts, except superiorly and inferiorly to a small extent. From an elliptical opening in the upper part, protruded a bleeding fungus, the size of half a hen's egg." He states: "This operation far surpassed in tediousness, difficulty, and danger anything which I have ever witnessed or performed. It is impossible for any description which we are capable of giving to convey an accurate idea of its formidable nature. The attachment of the morbid mass to the important structure of the neck and shoulder of the left side, and to so great an extent, is sufficient to indicate its magnitude and difficulty." The wound healed by granulation. It is interesting to note Mott's statement that "the immense chasm which was left, and such important parts as have been described only covered with lint, necessarily occasioned great solicitude until suppuration was fully established and the great vessels covered by granulations."

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* Read before the American Surgical Association, May 3, 4, 5, 1910, at Washington, D. C.

Mott states that by means of an apparatus contrived by Mr. James Kent, a most ingenious and inventive artist, to supply the want of the clavicle, he was so fitted as to have his shoulder in its proper position, at the same time that the full motion of his arm was preserved.

Comparatively few cases of total excision of the clavicle for malignant diseases have been reported by American surgeons. G. Norkes,[1] in 1893, published a case observed at Brun's Clinic, and made a very careful analysis of the cases reported in the medical literature up to that time. He found 31 cases of total excision for non-malignant and 32 for malignant tumors, of which 24 were sarcoma, 5 carcinoma (?), 2 exarthrosis, and one chondroma, with 6 deaths. It is probable that the cases put down as carcinoma were sarcoma, as primary carcinoma of the clavicle is practically unknown. Only one case died of septicæmia. Warren's case died four weeks afterward, of pleuritis or possibly metastases. Langenbeck's case died six days later from a swelling of the dura mater; Politz's case died on the eleventh day, from brain tumor, Sajous's on the eighth day, of fascial metastases; in Eves's case the cause of death was doubtful.

The immediate results in the majority of cases as regards usefulness of the arm were remarkably good. In many cases, without the use of apparatus of any kind the patients were able to use the arm as well as before.

As regards end-results, the statistics of Norkes are extremely deficient; only 2 cases are known to have lived and remained well beyond two years.

Since the publication of Norkes's paper in 1893, I have been able to find in the medical literature reports of 20 additional cases. Adding to these 10 thus far unreported cases, which have come to my notice through personal communications from the surgeons who performed the operations, we have a total of 62 cases.

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[1] Beitr. z. klin. Chir., 1893, Band xi, p. 729.

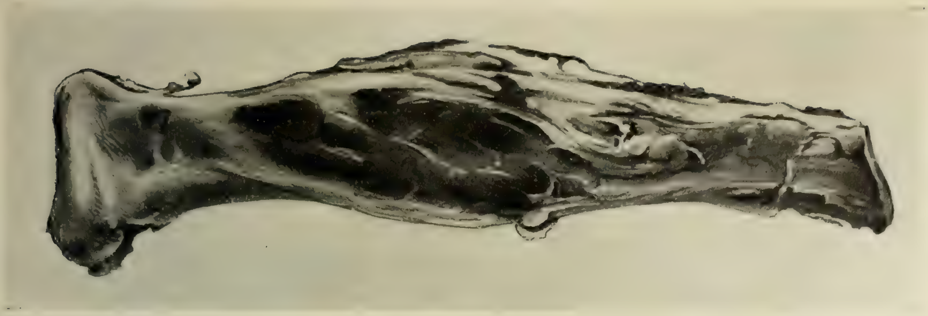
It is with special reference to the following unpublished cases and especially those which have come under my own observation that this paper has been written.

CASE I.—*Sarcoma of the clavicle; round-celled; total excision* (author's case). J. V., male, aged 16 years.

*Family History.*—Good.

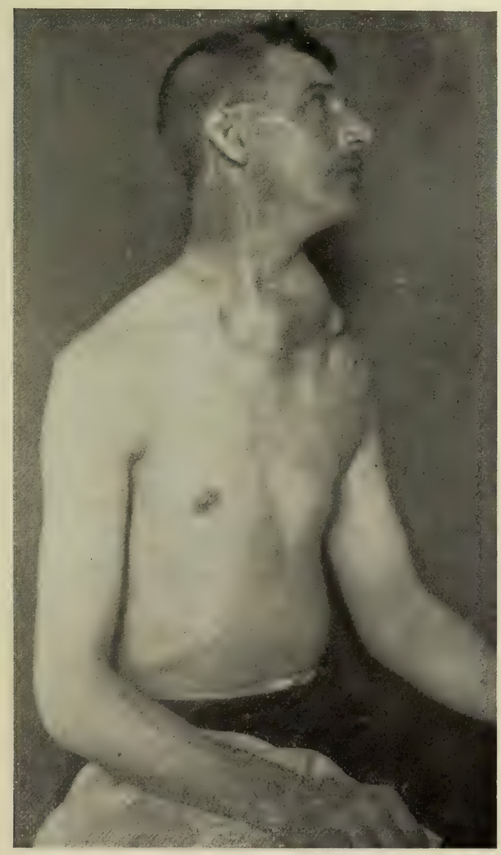
*Past History.*—Always well until the beginning of October, 1909, when, going down stairs he tripped and fell. Trying to save himself, he caught hold of the banister with his left hand, which brought him up so suddenly that it caused a good deal of strain upon his left shoulder and clavicle. Shortly after that, while riding a motor cycle, the latter broke down and he was obliged to tow for a distance of ten miles, during which time he held on to the tow iron with the left hand. End of October, he first noticed pain and soreness in the region of the left clavicle, but did not notice any swelling until a week later. He consulted Dr. Alfred Potter, of Brooklyn, November 20. Dr. Potter found a fusiform enlargement of two-thirds of the inner portion of the shaft of the left clavicle. He had an X-ray made which presented the appearance of a typical periosteal sarcoma. The outline of the periosteum was very nearly lost; no enlarged glands were present. The tumor was about the size of an English walnut. The patient's general health was good; there was very little pain. The clinical history, physical signs, and the X-ray photograph made the diagnosis of sarcoma sufficiently certain, in my opinion, to warrant removal without subjecting the patient to the danger of an exploratory incision. Accordingly, two days later, November 22, 1909, with the assistance of Dr. W. A. Downes, I performed the operation of total excision of the clavicle. The incision was made over the outer surface of the clavicle over its entire length, and after separating periosteum and bone, Gigli's wire saw was passed beneath the clavicle one and a half inches from the outer extremity, well beyond the tumor. The inner and larger portion was then lifted up and dissected from the subclavian muscle and separated from its attachments until the sternocostal articulation was reached. Disarticulation was then accomplished with little difficulty and no hemorrhage. The outer

Fig. 1.



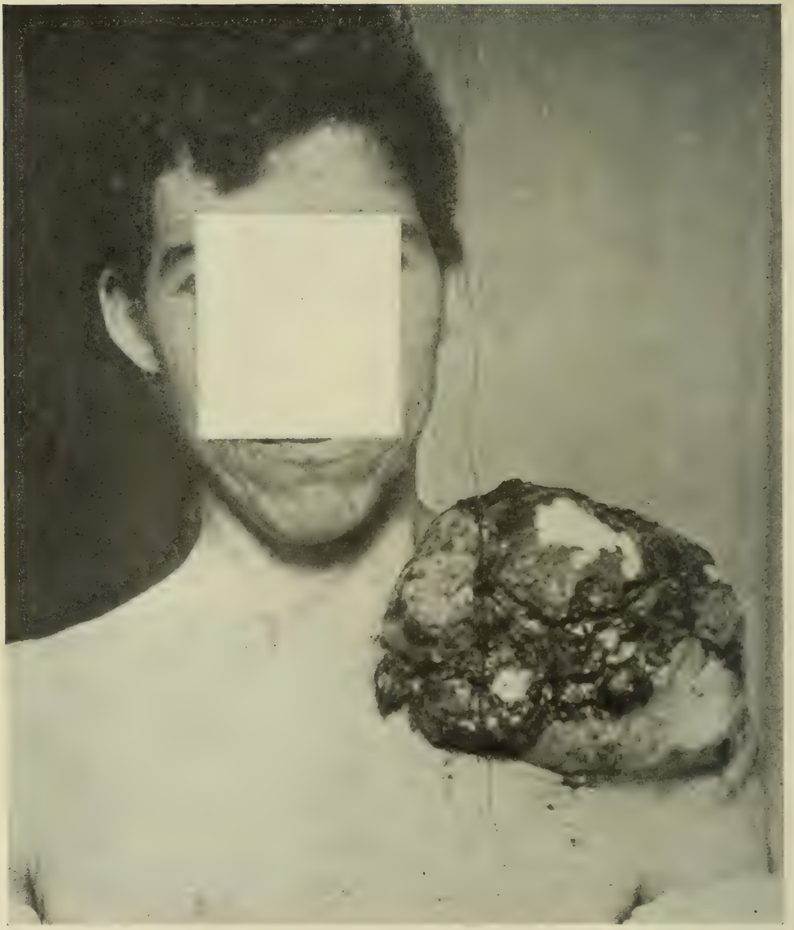
**Total** excision of clavicle for sarcoma of three weeks' duration in a boy aged sixteen years (Coley).

Fig. 2.



Recurrent sarcoma of clavicle six months after operation.

FIG. 3.



Sarcoma of clavicle of nine months' duration.

portion of the clavicle was thereupon removed by a rongeur forceps. The wound was closed, leaving a small cigarette drain. The patient made an uninterrupted recovery, the wound healing by primary union, and left the hospital at the end of ten days. Before leaving the hospital, he was put upon the mixed toxins of erysipelas and *Bacillus prodigiosus* in small doses, which were steadily continued by his family physician for a period of three months; the patient then considered himself so well that he refused further treatment. At the present time, November, 1910, almost a year after operation, the patient is in perfect health.

CASE II.—*Sarcoma of the clavicle; total excision* (DR. M. H. RICHARDSON) *followed by one year's treatment with the mixed toxins; patient well two years and a half.* J. W. H., aged 34 years.

*Family History.*—Father died of cancer of the stomach; no tuberculosis in family.

*Past History.*—Six or seven years ago a plank fell over and struck the patient upon the left clavicle, nearly knocking him down. He first noticed a swelling of the clavicle in January, 1908. A few weeks later, slight pain developed. He consulted a physician on January 19, 1908, who said he was unable to make a diagnosis. The swelling continued to increase slowly, and March 23 he consulted Dr. Hunt, of Bangor, Maine, who said it was sarcoma. The diagnosis was concurred in by Dr. S. W. Johnston, of Belfast Maine, who referred the patient to Dr. Maurice H. Richardson, of Boston. The latter did a total excision May 18, 1908. The tumor occupied the middle and inner thirds, and operation was difficult. Microscopic examination showed it to be small, round-celled sarcoma. As soon as the wound healed, Dr. Richardson referred the patient to me for the toxin treatment as a prophylactic against recurrence. At this time there was considerable infiltration in the whole lower cervical region, which was very suggestive of either a recurrence or incomplete removal. This gradually cleared up under the toxins and had entirely disappeared at the end of two months. The treatment was carried out under my direction by the family physician, Dr. H. L. Trulock, of Dixmont, Maine. The dose was gradually increased until he received 20 mm. Examination was made by myself in February, 1909, as also in July and October, at which time he had gained twenty-six pounds in weight and was in perfect health. The same is true at the present time, two years after operation. Dr. Richardson stated that he considered the absence of a recurrence in this case entirely due to the toxin treatment.

CASE III.[2]—DR. THOS. W. HUNTINGTON'S case (San Francisco, California, September 5, 1908). Mr. X., Pinole, California.

*Family History.*—Negative. Lues, negative; habits exceptionally good.

*Past History.*—Never had any serious illness. For the past eighteen months has been under Dr. Huntington's care for double salivary fistula.

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[2] Dr. Huntington has kindly given his permission to include this unpublished and very important case.

Case not clearly made out and due to stenosis of Stenson's duct. One sinus is still open.

*History of Present Trouble.*—In September, 1906, while carrying a steel shaft with a fellow workman, his companion dropped his end, whereby Mr. X. sustained a severe contusion or bruise of the right clavicle at the junction of the outer and middle thirds. An enlargement at this point appeared within the next two or three weeks. This remained stationary for many months, but never wholly disappeared. Four months ago it began to grow quite rapidly, attaining its present size one month ago, since which time it has remained stationary.

*Present Status.*—The skin over the outer portion of the clavicle is reddened superficially, the area of redness covering a mass which is clearly associated with the shaft of the clavicle. The mass appears to be about the size of an ordinary English walnut, slightly elongated at the ends. The mass is indurated and irregular in outline. Fundus of the mass is clearly fluctuant. The largest diameter of this mass is fully twice that of the clavicle shaft. On examination the sensation conveyed is that the mass contains a fluid content in the centre, the outer portion remaining crater-like. It is sensitive upon pressure, but otherwise is painless. The patient's general health is fairly good, and he seems, thus far, not to show any general deterioration.

*Operation,* September 8, 1908.—At the University Hospital, Dr. Huntington resected the entire clavicle, removing a segment of skin overlying the centre of the tumor. Macroscopic appearance of the tumor verified the conditions outlined above. The tumor had undergone a degeneration in the centre. Contents, thick grumous material. The margins of the tumor arose from the periosteum, and though the shaft itself was involved, the pathological report was to the effect that the tumor was spindle-celled sarcoma of periosteal origin. The shaft of the bone had participated in the process secondarily. The operative wound was left open in the centre, but healed slowly by granulation after a period of nearly three months. At the end of two weeks, treatment by Coley's toxins was begun and continued for about five months.

On April 12, 1910, the patient was in excellent condition. Both parotid fistulas had been closed for many months.

Cases IV and V.—Mr. Gilbert Barling's cases, Birmingham, England (personal communication). (1) Miss S., aged 10 years, May, 1901. An injury to the left clavicle, doubtful fracture, probably not, but it seems likely that some swelling has existed in the region of the clavicle ever since that injury. When seen by me on January 22, 1902, a mass the size of the fist over the left clavicle, apparently fluctuating in parts, skin adherent and rather dusky, veins very much dilated; the swelling extended from half an inch outside the sternoclavicular joint nearly to the outer end of the clavicle; no swelling of the arm, no numbness or loss of power in the arm.

*Diagnosis.*—Sarcoma. Removal advised, but operation is not one that could strongly be recommended.

January 28, 1902: Complete removal of the left clavicle. There was very troublesome bleeding from small vessels but no injury to the large veins. It was noticed that there was a good deal of œdema over the growth, as though it were of an inflammatory nature. The thoracic duct was injured, and chyle escaped into the wound but not in any large quantity. The small opening in the duct was closed by a lateral ligature.

The patient made a good recovery, but on February 1, 1902, it was noticed that there was a good deal of milky fluid escaping from the wound; this continued for several days in gradually diminishing quantities. The patient was up ten days after the operation.

Note on September 2, 1902: There was extensive recurrence in and around the scar impossible for removal. The patient died a few months afterward.

(2) *Spindle-celled sarcoma of the clavicle.* Seen April, 1889. Male, aged 33 years. Growth had existed several months and there was a fracture through the middle of it, produced probably by the manipulations of a bone setter who had been treating the patient. The growth was mainly of the inner half of the clavicle, was firm in consistence, without evidence of cystic formation.

*Operation,* April 12, 1889.—The operation went well, there was no injury to any of the big vessels, but there was straightaway infection of the wound and the patient died on the fourth day after the operation from suppuration extending down the mediastinum and giving rise to pleurisy.

CASE VI.—*Sarcoma of the clavicle, periosteal; total excision* (HARTLEY); *recurrence three months after operation.* G. M., aged 19 years.

*Family History.*—Good.

*Past History.*—No trauma.

First noticed a small lump above the left clavicle in March, 1907. He thinks it was movable at first, and states that it disappeared. A month and a half later the swelling reappeared and seemed to be attached to the clavicle. He consulted a physician, who treated him for rheumatism for a number of months. The tumor continued to increase in size. In April, 1909, he went to the New York Hospital and was admitted to the service of Dr. Frank Hartley, who did a total excision. The microscopic examination was made by Dr. Elser, who reported the disease to be a spindle-celled sarcoma. Three months later the patient noticed a local recurrence above and below the former site of the scapula. The patient was then referred to me, and I had him admitted to the General Memorial Hospital, September 28, 1909. By this time the patient had several recurrences occupying the whole upper portion of the right chest; the recurrent masses varied in size from a marble to three to four inches in diameter, and were situated beneath the pectoral muscle. Several smaller lumps had also appeared underneath the old scar and pectoral region (see illustration). The toxins were begun in small doses and gradually increased up to 14 minims. After two weeks there was considerable decrease in size of the various nodules and increased mobility. Shortly after that, however, the control was lost and the tumors again began to increase in size. December 1, 1909, it seemed useless to continue the treatment, and the patient was discharged from the hospital unimproved.

CASE VII.—*Round-celled sarcoma of the clavicle.* E. S., male, aged 21 years. In May the patient broke his left clavicle. One year afterward a swelling appeared at the site of the fracture and grew rapidly. The clavicle was partly removed by operation, but the disease quickly returned, soon involving the scapula. The patient was treated by myself with the mixed toxins for about four weeks, but without success. Excision of the remaining portion of the clavicle, the entire scapula, and upper extremity was later performed by Dr. W. W. Keen, of Philadelphia. The patient recovered from the operation, but died eight months later from a recurrence.

The following cases of sarcoma of the clavicle I have personally observed, but no operation was done on account of the extent of involvement when first seen.

CASE VIII.—*Sarcoma of the clavicle, recurrent; trauma.* W. F., male, aged 38 years.

*Family History.*—Always well until December, 1908, when he swung from trolley car, grasping rail by left hand. Immediately thereafter pain set in over the inner third of the clavicle; this subsided, but a week later he noticed a bony lump which he thought was the overlapping of the collar-bone. This tumor slowly increased in size, and three to four weeks later he consulted a surgeon who sent him to the Long Island College Hospital, where the diagnosis of tumor of the left clavicle was made. Operation was performed on February 5, 1909. The wound healed by primary union and the patient left the hospital on February 28. A week later he noticed a lump in the suprasternal fossa; this was painless, but gradually increased in size, and he returned to the hospital March 28. The treatment with the mixed toxins was begun, but discontinued after a few weeks, as there was no appreciable improvement. When I saw him a few weeks later the growth was so very extensive and signs of metastasis were already evident that I abandoned further treatment.

CASE IX.—H. K., aged 31 years.

*Family History.*—Good.

*Past History.*—In May, 1897, carried a heavy piece of steel on the right shoulder; one month later he noticed a lump directly over the clavicle at the point where the steel rested. The first operation was done by Dr. Mayer, of Buffalo, in July, 1897, who removed a gland below the clavicle, the size of an English walnut; three weeks later a lump appeared in the axilla and rapid involvement of the surrounding tissues quickly followed. When I saw the patient, February 16, 1898, his general condition was very poor; he was confined to the bed most of the time; his right arm was greatly swollen down to the tips of the fingers. The whole neck and shoulder were occupied by an enormous tumor extending to the sternum in front and nearly to the vertebral column behind; the skin over the tumor was of a deep purplish color and the patient was unable to move the arm at the shoulder. No treatment advised.

*Prognosis.*—Six weeks to two months of life.

Case X.—J. L., male, aged 8 years.

*Family History.*—Negative.

*Past History.*—Had a bad fall from a stone fence in October, 1905, injuring right shoulder and clavicle. Soon after a small lump formed in the clavicle; this was very soft and was supposed to be an abscess by his physician, who lanced it. End of December there was a recurrence, and in January, 1906, an exploratory operation was performed by Dr. Bodine, but it was impossible to remove the entire tumor. There was rapid increase of the disease thereafter and evidence of lung involvement. The patient was seen by me in March, 1906. Physical examination at this time showed the patient much emaciated; respirations, 40; pulse, 120 to 130; the right lung was nearly solid, and a large tumor in the region of the right clavicle infiltrated the adjoining tissues.

Case XI.—T. B., male, aged forty-six years; good family history; antecedent trauma dislocation of shoulder. In June, 1902, he first noticed a stinging pain in the inner portion of the left clavicle. Shortly afterward, a small enlargement was noticed in this region. He began X-ray treatment under the direction of Prof. J. Collins Warren, in November, 1902, and continued until March, 1903, two to three times a week, with considerable diminution in size of the tumor. In October, 1903, a specimen was removed by Dr. Warren and found to be round-celled sarcoma. The X-ray treatment was then resumed and continued until February, 1904, with the result that the tumor almost entirely disappeared. Later, however, it began to increase again in size and a third series of treatments was begun in August, 1904, and continued until October, 1904, with little effect. In October, 1904, the patient was referred to me by Dr. Warren for the mixed toxin treatment. Physical examination at this time showed a pear-shaped tumor, occupying the sternal portion of the left clavicle, 2½ x 5½ in. in diameter, occupying about two-thirds of the inner portion of the clavicle. The skin was normal and not adherent. The glands above and below the clavicle were somewhat involved, and there was slight enlargement of the left arm. The mixed toxins were administered in the pectoral region and buttocks from October 6 to November 26, 1904, during which time 31 injections were given in doses ranging from ½ to 4 minims, with moderately fair reactions, the temperature ranging between 99° and 102°. The X-ray treatment was given in conjunction with the toxins, three times a week. At first there was slight retardation of the growth, but later there was no apparent effect; the tumor again continued to increase in size and the treatment was abandoned. The patient grew worse steadily and died about a year later.

Case XII.—H. B., male, age twenty, electrician. Family history good. No single trauma but accustomed to carrying heavy materials upon left shoulder, *e.g.*, iron pipe.

Pain in shoulder for more than a year before any tumor was noticed. Small tumor first observed on outer portion of left clavicle in January, 1910. Operation (Dr. Stewart, Newport, R. I.) March, 1910. Tumor size of English walnut removed from outer end of left clavicle. Clavicle itself not resected. Microscopical examination showed tumor to be round-celled sarcoma, periosteal. Recurrence in three weeks. Very rapid growth followed. Patient under my care at General Memorial Hospital September 15 to October 20, 1910. Mixed toxins given in as large doses as deemed safe. Result little or no effect in controlling growth. Treatment discontinued. Prognosis, two or three months of life.

The Diagnosis of Sarcoma of the Clavicle.—That the diagnosis of cancer of the clavicle must be made early if there is to be a probability of saving the patient, a study of the collected cases makes very clear. It is true that Mott's case was far advanced, but it was of central origin, not of the more malignant periosteal type. No variety of tumor is more malignant than many of these cases of periosteal sarcoma of the clavicle. The proximity of large vessels insures an abundant blood supply, and consequently we have early infiltration and very rapid generalization.

That the diagnosis of sarcoma of the clavicle in the very early stages is possible is shown by my own case, in which total excision was performed three weeks after the swelling was first noted.

A distinct history of antecedent trauma was noted in 7 of the 9 cases of sarcoma of the clavicle personally observed. In most cases there was a history of a swelling having been noted a short time after the receipt of an injury. This swelling is intimately connected with the bone, of hard, firm consistence, not usually the "bony hardness" described by Mott, but often there is a slight yielding on deep pressure; the skin is normal in the early stages; later there may be dilated veins, but it is never adherent to the deeper structures except in the very late stages—too late for any attempt at operation. Pain is usually absent. The neighboring glands are seldom enlarged.

X-ray examination is of very great aid in diagnosis, especially in tumors of central origin. In most cases of periosteal sarcoma the X-ray plate will show a fairly characteristic picture. The sharp outline of the bone is nearly always lost, although I have just had a case of periosteal sarcoma of the femur in the early stages, in a girl aged twenty years, in which the outline was absolutely distinct, the probable explanation being that she was seen at such an early stage that no infiltration of the bone proper had taken place as yet.

One must differentiate the condition from tuberculosis. A history of tuberculosis in the family, or evidence of tuberculosis in the glands or some other portion of the body, would justify one in ruling out sarcoma. It is extremely rare to find primary tuberculosis of the clavicle. Sarcoma is prone to occur in strong and healthy individuals—more often in the young or middle-aged than the elderly.

*Syphilis.*—A history of syphilis may usually be elicited by careful questioning; in addition, a physical examination would probably show other bones than the clavicle affected. Besides, a syphilitic tumor would be of much slower growth.

*Myositis Ossificans.*—This in itself is a rare condition, and I do not know of any cases that have occurred in the clavicle. The X-rays would be of very great help in making the differential diagnosis.

If clinical history, physical examination, and X-ray findings all point to sarcoma, shall we then cut into the tumor and remove a section for microscopic examination before performing the operation of complete or partial excision of the clavicle? In most cases, I should say " no "; at least, I would prepare for the major operation, and, in case of doubt, would have a microscopic examination made from the frozen section at the time of operation. But, in some cases—my own among the number—it is impossible to make a satisfactory examination from the frozen section, for the reason that decalcification of the bone must first be made.

To one who has had large experience in operations upon sarcoma of the bones, macroscopic examination of the tissue, together with the clinical history and physical signs, will, in nearly all cases, be sufficient to make an error of diagnosis exceedingly rare. Therefore, in a rapidly growing tumor of the clavicle, I would perform total or partial excision, according to the condition found in the individual case, without waiting for the result of a microscopic examination. In some cases it is possible to make frozen sections at the time of operation which might be of some value.

After operation, as soon as the wound has sufficiently healed, I would very strongly urge prolonged treatment with the mixed toxins of erysipelas and *Bacillus prodigiosus*, as a prophylactic against recurrence.

In the cases thus far reported, there has been an early recurrence in the great majority of cases that have been traced. Only three cases are known to have been well beyond a period of three years.

The prophylactic treatment with the toxins is entirely free from danger and can easily be carried out by the family physician.

Of course, it would be unscientific to claim that, because a number of cases of sarcoma in which the toxins had been used after operation remained free from recurrence, this result was due to the use of the toxins. Unless the number of cases were very large, such results might be explained by coincidences, without any relation of cause and effect. Yet the fact that in the cases of sarcoma of the long bones generally, in which the toxins have been used, recurrences have been less than one-third as frequent as in the cases in which they were not used, would seem to justify the conclusion that the treatment played some part in lessening the number of recurrences.

I did not advocate the toxins as a prophylactic after primary operation for sarcoma until comparatively recently, and not until I had seen a large number of cases of inoperable sarcoma entirely disappear under the treatment and remain permanently cured. If the toxins can cause a disappearance and final cure in such far-advanced, inoperable cases of sarcoma, a logical and entirely reasonable inference is that the toxins used after primary operation would be still more likely to destroy the few infected cells left behind that form the basis of future return.

The influence of trauma upon the development of sarcoma, and, in fact, upon the development of all types of malignant tumors, is a question which has elicited much discussion pro and con. Phelps, in the ANNALS OF SURGERY, June, 1908, made an elaborate attempt to disprove any causal relationship between trauma and the development of cancer; he limits the discussion to carcinoma.

For more than twenty years I have made a very careful study of the relationship between injury and the development of malignant tumors, and I have become more and more firmly convinced that injury plays a most important rôle in such development, both in sarcoma and in carcinoma. These cases of sarcoma of the clavicle show more strongly than any others, perhaps, the intimate connection between an antecedent trauma and the sarcoma. The association of the injury with the rapidly following development of the tumor would appear far too striking to be easily explained away as a mere coincidence.

*Trauma.*—Of the 9 cases of sarcoma of the clavicle there was history of trauma in 7 of the cases, and in one of the two remaining cases the patient had carried heavy weights upon the clavicle in which the sarcoma developed.

Case I: Sarcoma of the left clavicle; a heavy plank fell upon the left clavicle six years before.

Case II: Sudden severe strain of shoulder while getting off a trolley car; immediate pain; tumor noticed one week later; operation four to five weeks later.

Case III: Severe strain of clavicle from grasping banister to prevent falling down stairs; tumor noticed one week later.

Case IV: Dislocation of shoulder; tumor of clavicle noticed two to three months later; round-celled periosteal.

Case V: Fractured clavicle; tumor appeared one year later at exact site of fracture.

Case VI: Had a fall from stone fence, striking on clavicle; tumor appeared almost immediately after.

Case VII: No trauma.

Case VIII: Bruised by carrying heavy bars of steel upon shoulder and clavicle; tumor developed at the exact site, one month later.

Case IX: An electrician, and habitually carried heavy materials upon shoulder of side in which sarcoma developed.

ANALYSIS OF THE CASES.—As regards the age of the patients, in 1 case the sarcoma was noticed at birth; 2 cases were between one and ten years; 19 cases were between ten and twenty years; 9 cases were between twenty and thirty years; 12 cases were between thirty and forty years; 7 cases were between forty and fifty years; 1 case was between fifty and sixty years; 3 cases were between sixty and seventy years.

As regards the type of the growth in the successful cases: Mott's case was probably of central origin, well fifty years; Wheaton's case, type not stated, well ten years; Norkes's case, myeloid growth, well five years; M. H. Richardson's case, periosteal growth, well two years; Huntington's case, periosteal growth, well two years; my own case, of central origin, well seven months.

Results of Operation.—Eleven cases died from the effects of the operation. In 1 case there was a recurrence four years after operation; in 1 case there was a recurrence eighteen months after operation; in 1 case a sarcoma of the femur developed three months after operation; in 1 case there was a local recurrence six months after operation; in 1 case there was a recurrence soon after; in 1 case there was a recurrence in the upper jaw nine years after operation; 1 case was well five months later; 1 case recurred a few months later; 1 case recurred within three months; 1 case recurred within two months. In these 10 cases recurrence was noticed within the first six months in 7 cases; 1 recurred in four years, 1 in eighteen months, and 1 in nine years. Six cases were well at the time of the last observation: Mott's case was well fifty years; 1 case well ten years; 1 case well five years; 1 case well two years; 1 case well one and one-half months; 1 case well seven months. In 3 of these cases the toxins were used immediately after operation as a prophylactic (Richardson's, Huntington's, and my own). In the remainder of the cases the final results are not known.

Conclusions.—1. Primary sarcoma of the clavicle, while a rare condition, requires very early diagnosis and very early radical treatment—total or partial excision as soon as the diagnosis has been made.

2. The mortality of the operation performed under modern aseptic conditions should be very small.

3. The danger of early local or general metastases is very great.

4. In view of the favorable results obtained in the few cases of sarcoma of the clavicle, and the much larger number of cases of sarcoma of the long bones in general, by the use of the mixed toxins of erysipelas and *Bacillus prodigiosus* immediately after operation, as a prophylactic, such use would seem to be strongly indicated as a routine measure.

## TABLE OF REPORTED CASES OF SARCOMA OF CLAVICLE.

| No. | Reporter. | Date. | Reference. | Sex. | Age. | Side. | Site. | Duration. | Description | Operation. | Type. | Result. | Final report. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Mott | 1829 | Amer. Jour. Med. Sci., 1828, iii, 100 | M | 19 | L | Beneath and adherent to clavicle | ...... | Size of two fists | ...... | Osteo. with ulceration | Recovery | Well 50 years | |
| 2 | Warren | (1832)<br>1837 | Surg. Obs. of Tumors, p. 405 | M | 24 | R | Inner end | ...... | ...... | Total excision | Pulsating | ...... | ...... | Died of pleurisy 4 weeks after |
| 3 | Travers | 1838 | Med. and Surg. Trans., xxi, 135 | M | 10 | L | Inner end | 1 year | ...... | Total excision | Osteo. | Recovery | Well 6 mos. | Trauma |
| 4 | Liston | 1844 | Lancet, p. 361 | M | .. | .. | ...... | ...... | ...... | Total excision | Soft | Recovery | Recurred in 3–4 months | |
| 5 | Chaumet | 1849 | Gaz. Med. de Paris | F | 18 | L | Outer | 9 months | Size of fist | Resection of external four-fifths | ...... | Recovery | | |
| 6 | Gallardon | 1847 | Gaz. des Hop. | F | 45 | .. | Middle, sternum, 1st rib | ...... | ...... | No operation | Vascular pulsating | ...... | ...... | Died of broncho-pneumonia |
| 7 | Rigaud | 1850 | Gaz. Med. Strasbourg, A. X., p. 103 | F | 15 | L | Inner | 7 years | Size of fist | Resection of inner two-thirds | ...... | Recovery | | |
| 8 | Owens | 1854 | New Orleans M. and S. J., xii, 64 | .. | .. | .. | ...... | ...... | ...... | ...... | ...... | ...... | ...... | Doubtful |
| 9 | Langenbeck | 1855 | Deutsch. Klinik | F | 11 | L | Both ends | ...... | ...... | ...... | Spindle cell | Died on 6th day | | |
| 10 | Syme | 1857 | Ed. Med. J., iii, Pt. I, 192 | F | 20 | .. | Outer end | ...... | $3\frac{1}{2}$ x $4\frac{1}{2}$ cm. | Total excision | Osteo.; myeloid cells; cystic | Recovery | | |
| 11 | Cooper | 1858 | Gaz. de Hop. | .. | .. | L | ...... | ...... | ...... | Total resection | ...... | | | |
| 12 | Esmärck | 1859 | Nissen. Diss. de resect. Kiliae | M | 33 | R | ...... | ...... | Size of a hen's egg | ...... | ...... | Recovery | Recurrence; died in 4 yrs. | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | Nélaton | 1860 | Thesis de Paris | F | 46 | R | Inner end and sternum | 2 years | ...... | ...... | Myeloid | ...... | ...... | Died of bronchitis |
| 14 | Gosselin | 1861 | Bull. Soc. de Chir., 2d series, ii | M | 37 | R | Inner third | ...... | Size of a lemon | Resection of inner third | Fibrous elements | ...... | ...... | Fracture |
| 15 | Pean | 1861 | Gaz. de Hop., p. 419 | M | 37 | .. | ...... | ...... | Size of a citron | ...... | Spindle cell | | | |
| 16 | Nélaton | 1863 | Bull. Soc. Anat., 2d series | F | 30 | .. | Middle | ...... | ...... | ...... | Fibrous and fibroplastic | | | |
| 17 | Richet | 1864 | Dict. de Med. et de Chir. Pratiq., viii | M | 65 | R | Inner third | 2 years | ...... | Resection of inner third | Myeloid | ...... | Recurred 18 months after in scar | |
| 18 | Paquet | 1867 | Bull. de la Soc. Anat., p. 634 | M | 21 | R | Inner end sternum, 1st rib | 6 months | 12 x 8 cm. | No operation | Embryonic and myeloid | ...... | ...... | Died |
| 19 | Delore | 1868 | Gaz. Med. de Lyon, iii, 93 | .. | .. | .. | Inner end | ...... | ...... | ...... | Medullary carcinoma | Recovery | ...... | Doubtful |
| 20 | Morin | 1868 | Ibid. | .. | Child | .. | ...... | ...... | ...... | ...... | Carcinoma | ...... | ...... | Doubtful |
| 21 | Meyer | 1868 | Gaz. Med. de Lyon, No. 8, p. 93 | .. | .. | .. | ...... | ...... | ...... | ...... | ...... | ...... | ...... | Doubtful |
| 22 | Sean and Eve | 1869 | Chicago Med. Exam., x, 653 | M | 12 | L | End | 14 months | ...... | Vein injured at operation | ...... | ...... | ...... | Cervical glands enlarged; died from exhaustion |
| 23 | Cooley | 1870 | St. Louis Med. and Surg. Jour., p. 62 | M | 30 | L | Middle | ...... | ...... | ...... | ...... | Recovery | | |
| 24 | Britton | 1870 | Brit. Med. Jour., i, 518 | M | 35 | L | Outer end | 2 years | Size of an orange | Resection of all except acrom. end. | ...... | Recovery | | |
| 25 | Eve | 1871 | Nashville Jour. Med. and Surg., i, 68 | M | 13 | L | ...... | 7 months | Size of an ovary | ...... | Enchondroma (red, flesh-like) | Died | ...... | Doubtful; spontaneous fracture |
| 26 | Richet and Demondre | 1873 | Paris Thesis | F | 51 | L | Outer end | 3 months | Size of an orange | Resection of outer end | | | | |

| No. | Reporter. | Date. | Reference. | Sex. | Age. | Side. | Site. | Duration. | Description | Operation. | Type. | Result. | Final report. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27 | Tausini | 1883 | Gaz. degli Ospitali, Milano, No. 39, p. 306 | F | 30 | .. | Inner end | ...... | Size of an egg | ...... | Myxœdema | Healed in 15 days | | |
| 28 | Deprès | 1885 | Bull. de Soc. de Chir., pp. 143–226 | F | 14 | R | Outer end | ...... | Size of an orange | ...... | Central | In hospital 31 days | | |
| 29 | Segoud | 1885 | Ibid. | M | 66 | .. | ...... | ...... | ...... | ...... | ...... | Died on 8th day of visceral involvement | | |
| 30 | Polleaillon | 1885 | Bull. de Soc. de Chir., p. 146 | M | 16 | R | Outer end | 18 months | Size of fist | Resection of external three-fourths | ...... | Recovery | Well 3months died of sarcoma of femur | |
| 31 | Kronlein and Ritter | 1885 | Inaug. Diss. Zurich | F | 17 | L | Central part | ...... | ...... | Total resection | Periosteal; round cell | ...... | Prompt recurrence; well 10 yrs. | |
| 32 | Wheeler | 1885 | Trans. Acad. Med. of Ireland | M | 43 | L | ...... | ...... | ...... | ...... | ...... | ...... | ...... | Slight blow; phthisis; imp.; well 10 years later |
| 33 | Sloan | 1887 | Am. Jour. Med. Sci., p. 485 | M | 14 | R | ...... | ...... | ...... | ...... | Carcinoma (?) | ...... | Recurred 6 months after | Doubtful |
| 34 | Heath | 1888 | Lancet, i, 721 | M | 30 | L | Outer end | 3 years, 10 months | ...... | ...... | Spindle and round cell | 7 days after operation developed br. symptoms | Died on 11th day | |
| 35 | Chiene | 1888 | Lancet, i | F | 15 | | | | | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36 | Wauscher | 1889 | Hosp. Tiden de Kopenhagen, Feb., i, 310 | M | 18 | .. | ...... | ...... | ...... | ...... | Myelogenous | ...... | Soon recurred | |
| 37 | Rouse | 1889 | Lancet, i. 575 | M | 29 | .. | Inner end | 6 weeks | Size of an egg | Resection of inner two-thirds | ...... | Died of sepsis | ...... | Vein injured |
| 38 | Jesset | 1889 | Lancet, p. 1077 | F | 18 | R | Inner end | ...... | ...... | ...... | ...... | Healed in 2 months | | |
| 39 | Harlam | 1863 | Brit. Med. Jour., p. 848 | M | 31 | .. | ...... | ...... | ...... | ...... | Periosteal; round cell | Primary union | Well 5 mos. | |
| 40 | Garre-Norkus | 1893 | Beitrag. zur. klin. Chir., ii | F | 31 | R | Outer end | 1 year | 2 in. long | Total excision | Myeloid; pulsating | Immediate recovery | Well 5 years | |
| 41 | Curtis-Norkus | 1893 | Am. Jour. Med. Sci., xxxiv, 350 | F | 20 | L | ...... | 5 years | ...... | ...... | Osteosarcoma | Recovery | ...... | Probably syphilitic |
| 42 | Leguen | 1895 | Bull. Soc. Anat. | F | 24 | .. | ...... | 3 months | Nut | Total excision | ...... | ...... | ...... | Pulmonary tuberculosis |
| 43 | Courtin | 1897 | Gaz. Hbd. des. Sc. Med. de Bordeaux, xviii | F | Birth | L | Middle and inner end | ...... | ...... | ...... | Osteo. | ...... | Lived 1 mo. | |
| 44 | Verstraete | 1898 | Jour. de Sc. Med. de Lille, i | M | 46 | R | Middle and inner end, 1st and 2d ribs | 7 months | Size of an orange | Total resection | Subperiosteal; encapsulated | Recovery | | |
| 45 | Besson | 1898 | Ibid. | M | 39 | R | External end | 7 months | Size of an egg | Total excision | Myeloid; periosteal | ...... | ...... | Operated on 9 years before for sarcoma of superior maxillary |
| 46 | Flament | 1898 | Ibid., ii | M | 10 | R | External two-thirds | 1 month | Size of an egg | Resection of external two-thirds | ...... | Recovery | Well 1 month | |
| 47 | Bourg | 1902 | Paris Thesis | M | 45 | R | Middle and inner end | 2 years | Size of an orange | Total resection | | | | |

| No. | Reporter. | Date. | Reference. | Sex. | Age. | Side. | Site. | Duration. | Description | Operation. | Type. | Result. | Final report. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 48 | Jonnesco | 1903 | Bull. et Mem. Soc. de Chir. de Bucarest, vi, 253 | .. | .. | L | ...... | ...... | ...... | Total resection | Osteo. | Recovery | | |
| 49 | Degonville | 1904 | Paris Thesis | M | 50 | L | Middle third | 2 years | ...... | ...... | Myeloid and round cell | ...... | ...... | Fracture; multiple fractures of ribs; died before operation; weighed when removed 1600 grams |
| 50 | Kryukoff | 1904 | Russk. Vrach., St. Petersburg, iii, 775 | F | 12 | R | ...... | ...... | ...... | Total resection | Round cell | ...... | | |
| 51 | Buteanu | 1905 | Bull. Soc. de Med., et Nat. de Jassey, xix. | .. | .. | .. | ...... | ...... | ...... | ...... | Osteo. | | | |
| 52 | Coley | 1909 | Unpublished | M | 16 | L | Middle portion, myelogenous, round-celled | 6 weeks | Size of an English walnut | Total resection followed by toxins | Periosteal | Recovery | Well at present, 1910; one year later | Toxins almost immediately after operation |
| 53 | Huntington, Thos. W. | 1908 | Unpublished | M | 39 | R | Outer and middle third | 2 years | English walnut in size | Total resection followed by toxins (Coley) | Spindle-celled periosteal | Recovery | Well 2 years | Followed a blow |
| 54 | Gilbert Barling, Birmingham, Eng.; personal communication | 1889 | Unpublished | M | 33 | .. | Inner half | Several months | ...... | Resection | Spindle-celled | ...... | Died on 4th day from suppuration of mediastinum and pleurisy | Fracture through middle of bone |
| 55 | Ibid. | 1901 | Unpublished | F | 10 | L | Middle and inner portion | ...... | ...... | Total excision | ...... | ...... | Recurred 9 months after, in scar; died a few months later | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 56 | Richardson, M. H.; personal communication | 1908 | Unpublished | M | 34 | L | Middle and inner third | 4 months | ...... | Total excision followed by toxins (Coley) | Small, round-celled | Recovery | Well 2 years and 2 mos. | Plank fell over striking patient on left clavicle |
| 57 | Hartley, Frank | 1909 | Unpublished | M | 19 | L | ...... | 2 years | ...... | Total excision | ...... | Recovery | Recurred in 3 months in side of chest | Toxins then used; temporary; unimproved only |
| 58 | Keen, W. W. | 1898 | Unpublished | M | 21 | .. | ...... | ...... | ...... | First operation partial; second, interscapular thoracic amputation; toxins | ...... | Recovery | Died 8 mos. later, from recurrence |  |
| 59 | Bodine (Coley) | 1906 | Unpublished | M | 8 | R | ...... | 3 months | ...... | First, lancing of abscess; second, partial removal of tumor | Periosteal; round-celled | ...... | Death in a few months | Received blow Oct., 1905 |
| 60 | Warren, J. Collins (Coley) | 1902 | Unpublished | M | 46 | L | ...... | 6 months | ...... | No operation; toxins; X-ray | Periosteal; round-celled | ...... | Died 1 year later | Trauma; dislocation of shoulder |
| 61 | L. I. College Hospital | 1909 | Unpublished | M | 38 | L | Inner third | 1 week | ...... | Operation (?) Partial removal | Rapid growth | Recurrence week later in suprasternal fossa; toxins then given with but little benefit | ...... | Strained shoulder |
| 62 | Stewart (Coley) | 1910 | Unpublished | M | 20 | L | Outer third | 2 months | Tumor size of English walnut, outer end of clavicle | Operation; Dr. Stewart, Newport, R. I., March, 1910 | Periosteal; round-celled | Recurrence 3 weeks; very rapid growth | Mixed toxins (Coley) Sept. 15, to Oct. 15, 1910; no effect on very large tumor | No single trauma, but habitually carried iron pipes and heavy material on left shoulder |
| 63 | Coley | 1898 | Unpublished | M | 31 | R | Outer end | 9 months | Tumor of enormous size | General condition very bad; prognosis, few weeks of life |  |  |  |  |

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# TRANSGASTRIC EXCISION OF CALLOUSED ULCER OF THE POSTERIOR WALL OF THE BODY OF THE STOMACH.

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GASTROJEJUNOSTOMY has proved an efficient means of relief for calloused ulcers which lie in the pyloric end of the stomach and are obstructive in character; but for the considerable number of cases in which the ulcer is located at some little distance proximal to the pylorus, this operation is often inefficient, and, at best, gastrojejunostomy leaves a cancer possibility which cannot be ignored.

It has been shown by Robson, Moynihan, and others, that gastrojejunostomy, though it gives relief to symptoms, does not protect the patient from later carcinomatous degeneration.

Three hundred resections have been performed in St. Mary's Hospital (Sept. 23, 1910). Two hundred and sixty-three of this number were subjected to careful examination in order to determine in how many of the cases cancer had its origin in ulcer, and it was shown definitely that 71 per cent. of the gastric cancers had developed on gastric ulcer.

The frequency with which malignant disease develops upon gastric ulcer leads to the conviction that chronic calloused ulcer of the stomach is treated best by excision, and in excising, if mechanical conditions are created which interfere with the progress of food, gastrojejunostomy for the purpose of drainage should be done as a supplementary procedure.

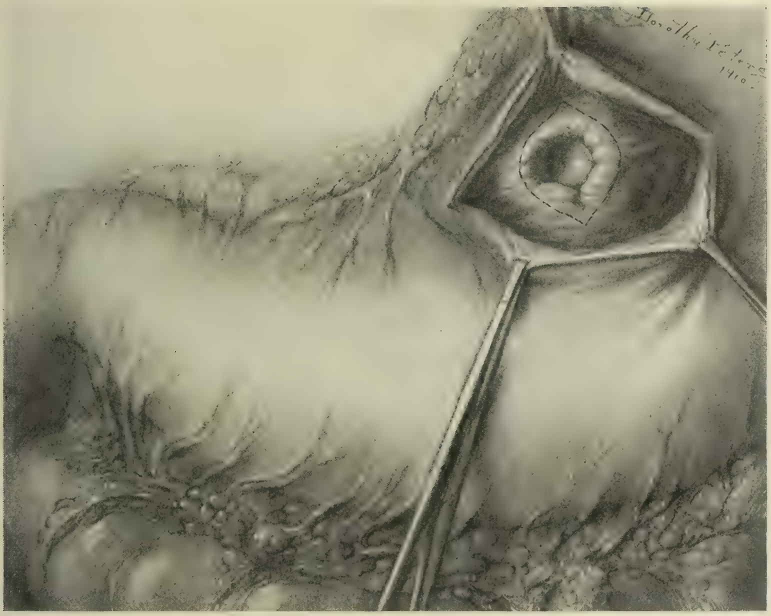
For ulcers lying in the pyloric end of the stomach, the Rodman operation is efficient, *i.e.*, partial gastrectomy with complete closure of the end of the duodenum and stump of the stomach, and independent gastrojejunostomy. This procedure is a rational application to a new field of the

Billroth operation number two for gastric cancer, and we have used the method a number of times with great satisfaction.

In saddle ulcers of the lesser curvature, excision may ordinarily be performed without difficulty, and the excision of an ulcer of the anterior wall of the stomach may be easily accomplished, but in the type of ulcers which occur on the posterior wall of the body of the stomach, which are so often adherent to the pancreas and other retrogastric structures, excision is most difficult. In several instances where there was hour-glass contraction, we have succeeded in making a resection in continuity with end-to-end anastomosis of the divided stomach ends.

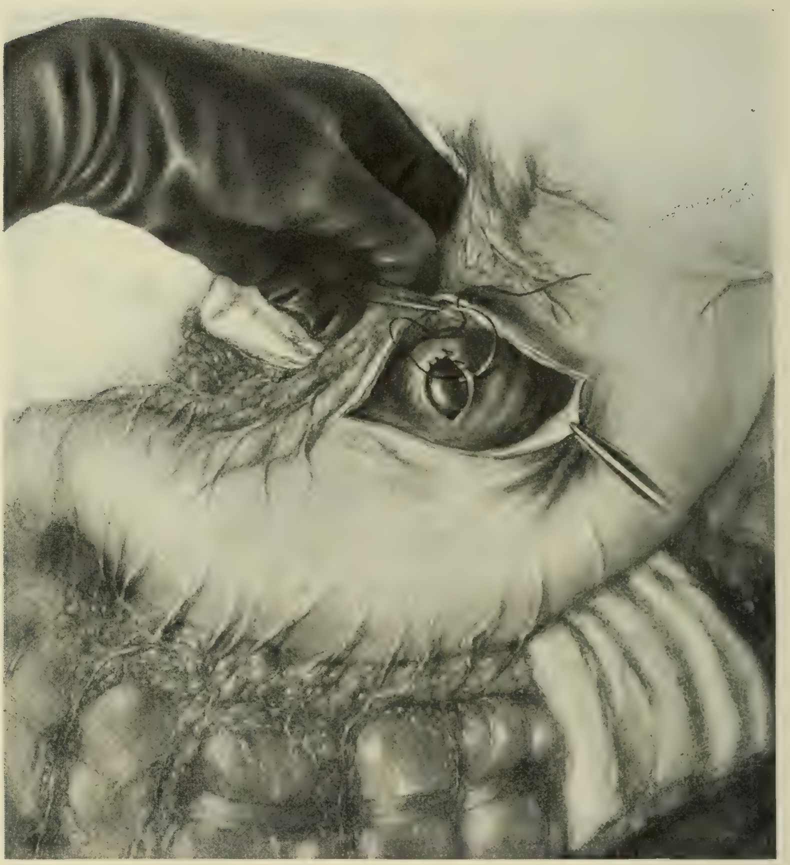
There are a number of posterior ulcers, however, in which none of these operative measures can be applied satisfactorily, and in such cases we have succeeded in making a transgastric excision of the ulcer through the anterior wall of the stomach. Our first transgastric excision of a calloused ulcer of the posterior wall of the body of the stomach was the result of an immediate necessity to meet an accidental complication. A male, forty-eight years of age, was found to have calloused ulcer of the posterior wall of the stomach about four and one-half inches above the pylorus. The ulcer was adherent to the pancreas, which formed the ulcer base. An opening was made through the gastrohepatic omentum, and an attempt made to separate the ulcer from the pancreas, hoping thus to bring it into view through the opening in the gastrohepatic omentum and excise it, or to perform a resection in continuity. These manipulations resulted in partially separating the ulcerated surface posteriorly, with immediate leakage of the stomach contents behind into the lesser cavity of the peritoneum. The gastric opening was plugged with a finger, the gastrocolic omentum opened below, and with some difficulty adequate protection was secured about the ulcer. It was impossible to get a view of the ulcer either from above or below, therefore the anterior wall of the stomach was opened to the extent of three and one-half

Fig. 1.



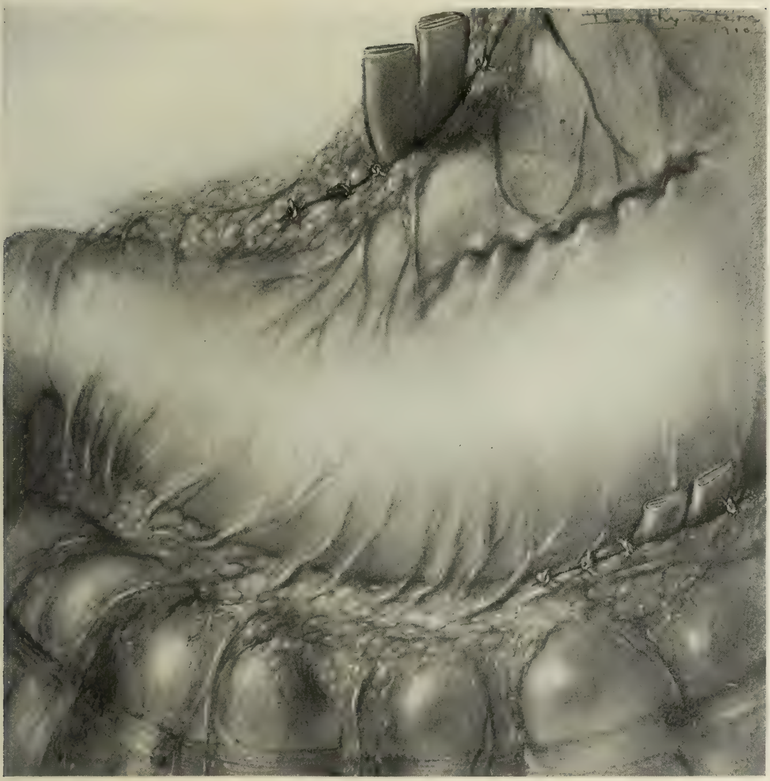
Transgastric excision of calloused ulcer of the posterior wall of the body of the stomach, showing anterior wall of the stomach open and the ulcer exposed. The dotted lines show proposed site of excision.

FIG. 2.



Ulcer excised, and the through-and-through mucous suture partially completed.

Fig. 3.



Anterior wall of the stomach sutured. Rubber-tissue drains in place.

inches in its long axis, and by retraction of the margins of the opening, a splendid view of the ulcer was obtained. The ulcer was excised with a knife, leaving it attached to the pancreas, from which situation it was shaved cleanly off. The cut margins of the posterior wall of the stomach were sutured from the mucous side by means of a running suture of heavy linen thread applied transversely to the long axis of the gastric cavity. The anterior wall of the stomach was closed with chromic catgut and linen. An attempt was then made to apply a peritoneal suture behind to cover the row which had been applied from the mucous surface. It was quickly seen, however, that serious damage would result in an attempt to secure the necessary exposure. Further examination revealed that the single through-and-through suture which had been applied from the mucous surface made a most satisfactory union without reinforcement. Three drains, composed of rolls of rubber tissue, were passed behind the stomach to the line of sutures to cover the site on the pancreas where the ulcer had been excised. These drains were brought out through the upper angle of the abdominal incision. There was no leakage or drainage, and the patient made a prompt and permanent recovery.

Connell, Coffey, and others have proved, clinically and experimentally, that the single suture is safe, and in the various instances in which we have applied the single through-and-through suture from the mucous surface, the result has been satisfactory.

We have performed the transgastric operation for removal of adherent calloused ulcers of the posterior wall of the body of the stomach five times, without leakage or evidences of infection, and with the recovery of the patient in each instance. The steps of the operation are as follows:

The gastrohepatic and gastrocolic omenta are opened above and below the ulcer. Gauze protection is introduced, adhesions are carefully separated, and, if possible, the ulcer surface is cut free from the posterior attachments without opening the stomach. A piece of gauze is packed into the denuded area behind, and in all but one of our cases this temporary pack was adequate to stop hemorrhage without the ligation of vessels. The anterior wall of the stomach is opened, and with the fingers behind, the entire ulcerated surface is pressed through the anterior incision and the ulcer excised (Fig. 1). The gap is sutured with through-and-through sutures of chromic catgut from the mucous side transversely, and this suture line is further protected by several mattress sutures of linen, applied from the mucous side to prevent separation due to the early absorption of the catgut (Fig. 2). The anterior wall of the stomach is then closed. Several rubber-tissue drains are carried down behind the stomach and brought out at the upper end of the abdominal wound as a safeguard (Fig. 3).

NOTE.—Dr. Lewis S. Pilcher informed me recently that in May, 1907, he made a transgastric excision of the posterior wall of the stomach in a similar manner, with a successful outcome. A report of the case was published in the *Long Island Medical Journal* of May, 1908, p. 187.

# RELATION BETWEEN APPENDICITIS AND DISTURBANCE IN THE GASTRO-DUODENO-HEPATICO-PANCREATIC PHYSIOLOGICAL SYSTEM.

## A REPORT ON THE EXAMINATION OF 5000 APPENDICES WITH A COMPARATIVE STUDY OF THE PATHOLOGY AND CLINICAL HISTORIES IN 2000 CASES.

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THE possibility of an etiological relationship between the appendix and pathological conditions in the stomach, duodenum, liver, bile passages, and pancreas arose as the result of an investigation of the embryology, anatomy, and physiology of these organs in view of clinical experience and pathologic findings in studying the material from 216 gastrectomies,[1] 365 cholecystectomies,[2] 5000 appendectomies,[3] three duodenal ulcers[2] (autopsy), and the experimental experience of Cannon,[4] Litthauer,[5] Tsunoda,[6] Roger,[7] and others, all of which, when taken together, strongly suggest that the appendix is at least a part of the etiology of conditions which have been and are being treated as local conditions but which may possibly arise secondarily.

The material for this investigation was furnished by the clinics of Drs. C. H. and W. J. Mayo, and E. S. Judd, St. Mary's Hospital, Rochester, Minnesota.

Embryology teaches us that the stomach, duodenum, liver, gall-bladder, and pancreas are developed from a small segment of the primitive alimentary tract, and that the parenchyma of these organs as well as the stroma, nerves, lymph- and blood-vessels are derived from these structures in the primitive digestive tract.

Anatomy reveals the same blood and nerve supply for these organs that existed when they were a part of the simple primitive tube.

Physiology demonstrates the remaining necessity for products of digestion to pass in contact with the same alimentary cells (now the liver and pancreas) with which they came in contact in the primitive individual.

Autopsy has shown that duodenal ulcers when they occur at or near the papilla of Vater are sometimes, if not always, associated with cholecystitis, and occasionally with chronic interstitial hepatitis (cirrhosis).

The first case, No. 27,238, was a male aged 60 years, who was operated upon for cholecystitis seventeen months before the last operation. He was improved for five or six months, and again had epigastric pain, jaundice, and vomiting. At the second operation, which was performed at St. Mary's Hospital, the gall-bladder was found distended, the common duct dilated, and the head of the pancreas very hard. A note at operation stated that, if a third operation should be necessary it should be cholecystenterostomy. The patient died on the twelfth day after operation. Post-mortem examination revealed a marked cirrhosis of the liver, chronic catarrhal cholecystitis (strawberry gall-bladder), chronic pancreatitis, chronic congestion of the spleen, and a chronic ulcer of the duodenum at the ampulla of Vater, about 1 cm. in diameter. There was almost complete stenosis of the common duct in the base of the ulcer.

The second case, No. 31,049, was a male, aged 58 years, who, four years before examination, had attacks of severe epigastric pain which radiated to the back. Seven weeks before the last operation he had similar attacks accompanied by vomiting. At operation the gall-bladder was drained for cholecystitis with one stone, and a hard mass was felt at the end of the common duct, which was thought to be carcinoma of the head of the pancreas. On the fourth day after the operation the patient died from a hemorrhage into the bowel, associated with tarry stools and hæmatemesis. At autopsy a duodenal ulcer 2 cm. in diameter was found. The lumen of the common duct extended apparently unobstructed through the base of the ulcer.

The third case, No. 31,501, a male, aged 56, had his first attack of pain in the epigastrium three months before examination. The pain was referred to the right costal arch. A week later he had severe pain in the same region. This was accompanied by slight jaundice, no vomiting, but fever and constipation. He suffered from gas belching, bloating, and headaches. At operation a large stone was removed from the neck of the gall-bladder, which it obstructed. The patient had a fatal hemorrhage into the bowel. At autopsy an ulcer of the duodenum was found.

Clinical experience presents strong evidence that there are gastric disturbances which are relieved and often completely dissipated by the removal of the appendix.[8]

Experimental physiology and pathology demonstrate that partial obstruction of the common duct is followed by cirrhosis of the liver;[6] and that irritants in the large bowel cause retardation of the muscular rhythm of the stomach and intestines;[4] and that experimental gastric ulcers which do not heal can be produced by trauma plus anæmia but not by trauma alone.[5]

Examination of the appendices removed in association with "pyloric spasm,"* gastric and duodenal ulcers, cholecystitis and cholelithiasis shows that there is a higher percentage of appendices with partially or completely obliterated lumina † in all of these conditions, than at general autopsy or at operation for appendicitis.

Specimens examined at autopsy and operation showed the following percentages:

| | | | |
|---|---|---|---|
| Autopsy in | 2549 cases,[9] | 17 | per cent. partially or completely obliterated |
| Pyloric spasm | 17 cases, | 17 | per cent. partially or completely obliterated |

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* "Pyloric spasm" has been used clinically to denote an indefinite, apparently functional disturbance in the stomach evidenced by indigestion, pain, bloating, and dyspepsia.

† Obliteration of the lumen of the appendix is practically universally accepted by pathologists to-day to be the result of a mild or acute inflammatory process. The increase in the percentage of the obliterated or partially obliterated lumina does not increase gradually with the increasing decade. The greatest increase and the greatest activity in the process occur during the period in which appendicitis is most common.[8]

| | | | |
|---|---|---|---|
| Appendicitis | 1005 cases, | 23.5 | per cent. partially or completely obliterated |
| Gastric and duodenal ulcers | 52 cases, | 26.9 | per cent. partially or completely obliterated |
| Cholecystitis | 57 cases, | 52 | per cent. partially or completely obliterated |
| Cholelithiasis | 118 cases, | 44.8 | per cent. partially or completely obliterated |

In the previous studies [2] it was found that 23.2 per cent. of 365 cases in which cholecystectomy was performed showed symptoms which began at or under twenty-five years of age, the period during which appendicitis is most common, and that 13 per cent. of these cases gave definite histories of pain and soreness in the region of the appendix. In 59 of these cases of cholecystitis the appendices were removed, and 69 per cent. showed undoubted gross or microscopical evidence of inflammation, varying from a chronic catarrhal condition to complete obliteration and periappendicitis.

In the examination of 2000 appendices with their histories, 52 per cent. of 175 cases of cholecystitis with and without stones gave histories of pain in the region of the appendix.

In 1147 histories, which include all the cases of appendicitis and appendices removed during operations for conditions other than cholecystitis with or without stones, there was a history of pain in the epigastrium or right hypochondrium in 13 per cent. In 9.4 per cent. there was pain in the "abdomen" and in 14.6 per cent. pain in the "abdomen which radiated to and became localized in the region of the appendix."

The ages of patients at onset of symptoms of appendicitis, pyloric spasm, duodenal ulcer, gastric ulcer, cholecystitis, and cholelithiasis are as follows: 23.5 (1005 cases), 24.2 (18 cases), 31 (30 cases), 35 (10 cases), 34.7, and 33.8 years respectively. These conditions come to operation in the same order at the ages of 25.5, 34, 41, 48, 39.6, and 39.9 years. This order is exceedingly important if subsequent observations on a larger series of cases confirm it.

It is the rational course of events to be expected upon the hypothesis that irritation in the appendix and cæcum reflexly cause gastric and duodenal disturbances, which in turn interfere with the mechanism of secretion, storage, and outflow of the bile, thereby producing conditions favorable for bacterial infection in these organs and the gall-bladder.

A consideration of the average duration from the onset of symptoms to operation, in appendicitis, cholecystitis, and cholelithiasis, reveals respectively 2, 4.9, and 6.5 years. It will be seen that the average duration in cases of cholecystitis lies between the average in appendicitis and cholelithiasis.

The question arises, is this a mere coincidence especially when we know that simple cholecystitis precedes gall-stones? Is there any relationship between these conditions? Are we dealing with a process which manifests itself in three stages, namely, appendicitis, simple cholecystitis, and cholecystitis with stones?

The average age at the onset of symptoms in these three conditions is also of interest, although there is not the same parallel. In appendicitis it is 23.5 years, in cholecystitis 34.7 years, and in cholelithiasis is 33.8 years. There is one thing to be considered, however, and that is the fact that the symptoms in cholelithiasis are likely to be more sudden and severe and therefore demand earlier attention than in simple cholecystitis.

There is a marked contrast between the percentage of appendices with partially or completely obliterated lumina at general autopsies and at operations for appendicitis, and that found in appendices which have been removed in association with cholecystitis and cholelithiasis. Twenty-three and five-tenths per cent. at operation, 17 per cent. at autopsy, and 52 per cent. in association with inflammation of the gall-bladder, have partially or completely obliterated lumen. Eight and seven-tenths per cent. of 2000 appendices were associated with cholecystitis.

In spite of the fact that a higher percentage of males were operated upon for appendicitis than females (55.5 per cent. males and 44.5 per cent. females), partial obliteration of the lumen occurred more often in females (55.2 per cent. females and 44.3 per cent. males). This may be one of the coincidents which lead to false deductions in all statistics, but the figures are sufficiently significant to be kept in mind as possible evidence of the probable fact that the inflammatory processes in the appendix cause disturbances in the bile passages directly or indirectly, in view of the fact that cholecystitis is decidedly more frequent in females than in males.

These figures, which are the result of examination of the histories and specimens of 2000 cases in which the appendix was removed for appendicitis primarily or secondarily to other abdominal conditions, are sufficiently important, not to prove, but to stimulate, a careful study of clinical histories with relation to the possibility that chronic inflammation in the appendix reflexly disturbs the gastro-duodeno-hepatico-pancreatic physiological system, thereby bringing about conditions whereby such lesions as gastric ulcer, gastric carcinoma, duodenal ulcer, cirrhosis, cholecystitis, cholelithiasis, and pancreatitis may be indirectly produced.

During the examination of histories and surgical reports of upper abdominal conditions in which a high percentage of appendices had obliterated or partially obliterated lumina, it was thought that perhaps the technical difficulties in removal of an appendix through a high incision might influence the percentage, in view of the surgeon's ability to recognize such pathologic lesions in the appendix by palpation more readily than less extensive conditions. With this possibility in view, all of the upper abdominal conditions which were not apparently gall-bladder conditions were studied with the following results. In this series there were 46 upper abdominal incisions with 15 (32 per cent.) partially or completely obliterated appendices. For comparison those cases of lower abdominal incisions were taken and in 223 cases, 85 (38 per cent.) appendices were partially or completely obliterated. In 275 cases in which the stomach, duodenum, gall-bladder, and pancreas were explored and reported negative through the lower abdominal incision (straight or muscle splitting), 99 (36 per cent.) of the appendices were either partially or completely obliterated. In all of the upper abdominal conditions examined through high incisions and in the cases reported negative through low incisions, there were apparently symptoms in the epigastrium which required investigation.

This is merely more clinical evidence that individuals who present a higher percentage of obliterated or partially obliterated appendices at operation do have symptoms referable to the epigastrium, and that the percentage is lower when no recognizable pathologic lesion was found than in cases in which definite changes were found. They are all suggestive enough to demand further experimental evidence upon the subject, and until they are disproven the surgeon should remove the appendix in all cases of chronic appendicitis and in association with lesions in the gastro-duodeno-hepatico-pancreatic physiological system when such an operation can be done with little or no extra risk to the patient. During laparotomies the appendix should be removed when such procedure does not materially add risk to the operation.

By this means there is a great possibility of reducing the number of lesions in that physiological system.

A careful study of the subsequent histories of all cases operated upon for appendicitis should be made in order to determine what percentage of them have developed gastric ulcer, gastric carcinoma, cholecystitis, cholelithiasis, cirrhosis, and pancreatitis.

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# THE TECHNIC OF APPENDICOSTOMY.*

## A CONSIDERATION OF THE PRESERVATION OF THE BLOOD SUPPLY OF THE APPENDIX IN THE OPERATION.

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SINCE Weir, in 1902, first ingeniously utilized the appendix for the purpose of irrigating the colon, the operation of appendicostomy has undergone many changes of technic.

The steps in the ideal, which is also fortunately the average case, are:

(*a*) Abdominal incision, preferably the intermuscular of McBurney.

(*b*) Turning out the appendix, and, when necessary, straightening it by releasing its mesentery while preserving its vascular supply intact.

(*c*) Suture of the cæcum adjacent to the appendix to the parietal peritoneum, carefully avoiding obliteration of any cæcal vessels.

(*d*) Closure of wound about the appendix.

I wish to emphasize the importance of steps *b* and *c* inasmuch as I had the misfortune of having the appendix slough in one of my cases which is detailed below. Moreover, upon inquiry I found that my experience was not unique, but that several colleagues had had a similar experience.

Mrs. X., age forty, weight 240 pounds. Health always good except for an attack of dysentery eight years ago. During the month prior to consulting me she suffered from severe diarrhœa, the dejecta gradually assuming a bloody character, and were accompanied by severe cramps and tenesmus.

Examination was difficult. Through the proctoscope the sigmoid prolapsed markedly, was ulcerated, and bled freely. No amœba were found. In spite of rest in bed, suitable hygiene, constitutional and local treatment over a period of three weeks, the patient did not improve and appendicostomy was proposed and accepted. I operated at the New York Polyclinic Hospital, March 21, 1908. The gridiron incision was employed, the meso-appendix tied off in part, and the cæcum at the base of the appendix sutured to the parietal peritoneum. While doing this the needle accidentally punctured one of the cæcal arteries going to the appendix and it was tied. The wound was closed in the usual way. Three days later the appendix sloughed, and after a septic temperature of ten days a large mass of fascia came away. Convalescence was uneventful from that time, but the two inevitable sequelæ followed, viz., fecal fistula and hernia. The former closed in due time, but the latter still requires an abdominal belt. The colon yielded to irrigations through the fistula and the patient is well to-day except for the hernia which cannot easily be repaired because of the loss of fascia and the obesity of the patient.

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* Read before the American Proctologic Society, June, 1910.

This experience stimulated the writer to a study of the circulation of the appendix from the surgical stand-point. To gain a comprehensive idea of the appendix as of any other part of the intestinal tract, one must refer to embryology.

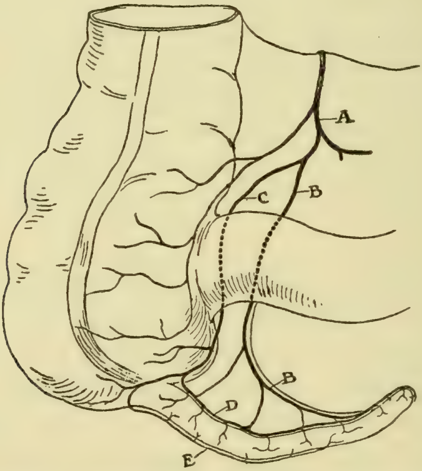
According to Huntington,[1] "The differentiation of the small from the large intestine, marked by the appearance of the cæcal bud or protrusion, takes place in the ascending segment of the umbilical loop a short distance from the apex. In the human embryo the cæcal bud appears in the sixth week as a plainly marked protuberance, which grows very slowly in length and circumference. It shows very early an unequal rate of development; the terminal piece not keeping pace in growth with the proximal portion is converted into the vermiform appendix, while the proximal segment develops into the cæcum proper."

Minot [2] states that "At six months the appendix is long and slender, *with a narrow free mesentery,* and is relatively much better developed than in the adult and is also less sharply marked off from the cæcum proper."

Briefly, then, the appendix is the vestige of the original head of the cæcum which failed to participate equally in development with the rest of that organ, and at a period prior to the sixth month of embryonal life, not possessing a mesentery, derived its sole blood supply from the cæcal vessels. The latter statement also holds true for the rudimentary and fetal forms of appendix, even in adults.

The vascular supply of the appendix is usually as follows: the descending branch of the colica dextra forms an anastomosing loop with the ascending branch of the ileocolic. From this loop the anterior and posterior ileocæcal arteries spring and are so named from their relation to the ileum. The former supplies the anterior surface of the ileum and lower cæcum but sends no branch to the appendix.[3] The posterior ileocæcal artery (see Fig. 1) passes back of the ileum close to the cæcum, and sends branches to ileum, lower colon, posterior cæcum, and appendix. The appendicular branch comes off from the posterior ileocæcal near its origin. The cæcal branch courses over the inner and back wall of the cæcum close to the appendix, to which it sends one or more branches.

Fig. 1.



*A*, posterior ileocæcal artery (partly schematic); *B*, appendicular branch; *C*, cæcal branch; *D*, constant, and *E*, variable branches from cæcal to appendix.

These two branches, then, of the posterior ileocæcal, viz., the appendicular and the cæcal, are for all practical purposes the sole blood supply of the vermiform appendix.

Parenthetically it must be remarked that the so-called ligament of Clido, the occurrence of which is denied by many anatomists and surgeons, but which according to that author exists in 10 per cent. of women, is a negligible quantity in connection with appendicostomy, since the appendicular artery which it is supposed to contain anastomoses with mesenteriolar-appendicular branches.

The branch from the cæcal above noted is constant and courses along the appendix on its mesenteric side, anastomosing with branches of the appendicular, while occasionally a smaller branch runs beneath the peritoneum opposite the attachment of the mesentery.

The appendicular artery divides into several mesenteric branches, usually three to five, of which the largest runs in the free border of the meso-appendix. It is for this reason that perforation is apt to occur where the mesentery ends from gangrene of the tip beyond this point.[4] In a number of dissections made by the writer on injected subjects this arrangement of vessels was found regularly. These observations are in accord with the statement of Poirier, Charpy, and Cuneo [5] viz.: " It is to be noted that this last artery (the appendicular) has slight anastomoses only with the cæcal arteries; it is almost terminal and its obliteration should involve the necrosis of the appendix."

Remembering, then, that the cæcal branch is the earliest and a constant source of blood supply to the appendix, and that the mesenteric branch is the more abundant in nearly all adults, also that the anastomosis between these vessels is very limited, they being somewhat terminal in character, the precarious nature of the arterial stream to the appendix became evident at once as well as the importance of not interrupting the current of either the cæcal or the mesenteric branch at operation if the vitality of the appendix is to be maintained entire. In a given case where the anastomosis is unusually free, either branch might be tied without danger, but at operation this point cannot be determined accurately, so the only safe clinical rule in practice is to respect and preserve both vessels.

At operation when uniting the cæcum adjacent to the base of the appendix to the parietal peritoneum, no difficulties are presented in avoiding the cæcal branches, as, fortunately, these vessels indicate their position by visible pulsation.

The mesenteric branches, however, require separate consideration. In some instances the appendix is so straight and the mesentery so narrow that it can be fixed in the wound at once. Most appendices, however, are falciform, as the mesentery is shorter than the appendix. To render their lumen fairly straight for the irrigating tube, it is necessary to free the mesentery. There are two ways of accomplishing this. One is to ligate and cut the mesentery at a point sufficiently distal from the base of the appendix that the blood supply is preserved to that portion of the appendix which traverses the abdominal wall. This method insures a viable organ up to the skin surface, but is open to the objection that the tip becomes gangrenous early and infection is apt to extend between the appendix and abdominal wound.

The other method, which is the one here advocated and in practice found free from objections, allows the appendix to be straightened sufficiently while preserving the vessels intact. Dr. Tuttle has applied this method in all his recent cases with marked success. It is accomplished by separating the two layers of the mesentery at its juncture with the posterior mural peritoneum, beginning at its free border, and carefully displacing the cellular tissue with its contained appendicular artery and branches as far as necessary toward the appendix. The two layers of peritoneum are divided transversely up to the base of the appendix, turned in, and sewed to obliterate the raw space on the posterior abdominal wall. It is unnecessary to test at once the patency of the lumen as advocated by some surgeons. This step adds an element of danger from infection. However constricted the lumen at first, it readily dilates to sufficient size. The danger is not that the calibre will be too small, but rather that it will be too large and leak fæces. Another great advantage of leaving the appendix intact till the wound has healed is that it may then be amputated about one centimetre from the skin, the teat-like prominence thus left giving easy entrance to the tube.

Further precautions are not to obliterate any arteries by ligatures, sutures, forceps, tension or torsion in fixing the appendix in a position where it does not rest naturally, or compression by closing the abdominal wound too snugly about it.

Bearing these points in mind, the operation of appendicostomy is on a par with an interval appendectomy as regards technic, speedy convalescence, and safety, the mortality being nil in my series of cases. Postoperative leakage of fæces and hernia, the two troublesome sequelæ of appendicostomy, are also avoided.

By practising this improved technic I am confident that results will be so satisfactory that appendicostomy will continue to grow in general favor over cæcostomy in all cases where prolonged irrigation of the entire colon is indicated.

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# ANOMALOUS RENAL ARTERIES AND THEIR RELATION TO HYDRONEPHROSIS.

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THE following variations are reported with a two-fold object: first, to discuss in some detail the more common irregular types of the arterial supply to the kidney; second, to call attention to the relation of such variations to operative procedures on the kidney and their importance as a causal factor in the development of deformities of the pelvis and ureter.

The variations herein reported were found in subjects dissected in the Anatomical Laboratory of the University of North Dakota. Our records include too few subjects to attempt any statistical conclusions at present, but the following cases illustrate the more common types of variation.[1]

CASE I.—Adult female, dead of tertiary syphilis. Kidneys and genitals otherwise normal, arterial system also essentially normal except that the superior mesenteric comes off the cœliac axis. The suprarenal receives a superior branch from the inferior phrenic, no middle branch, and an inferior branch from the accessory renal on the right side and from the renal on the left side. As shown in the drawing, the variation represents two types. On the right side, a truly supernumerary branch comes off the aorta about 4 cm. above the renal, passes behind the vena cava, and enters directly into kidney substance at the upper pole. On the left side, the single renal artery gives off a branch close to the aorta which is about 6 mm. in diameter. This passes behind the ureter to the lower pole of the kidney, where it branches inside of the capsule.

CASE II.—Adult male, dead of tuberculosis. No other essential abnormalities. On the right side the arterial supply to the kidney is normal, but there are three distinct renal veins, all entering the hilum behind the pelvis. On the left side two arteries of equal size come off the aorta at the site of the renal. One gives off the inferior suprarenal and itself passes to the hilum, where it sends one branch behind the pelvis and two in front of it. A second branch, just above, crosses the first in front of the pelvis to the lower part of the hilum. A third branch is given off the aorta opposite the lower pole of the kidney, which it enters after passing in front of the ureter. These branches are of about equal size, fully that of the radial.

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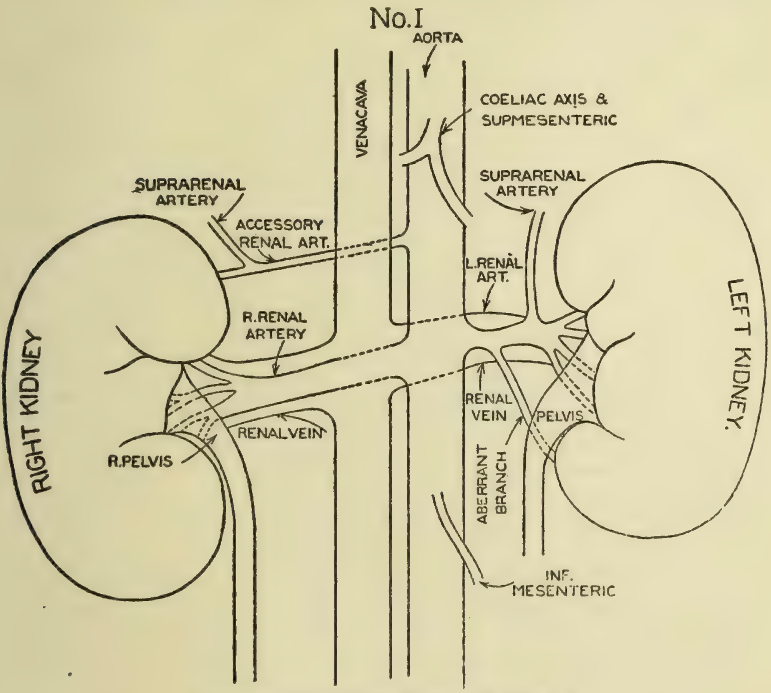
[1] Since the preparation of this article a report has appeared in the *Journal of the American Medical Association,* by Drs. Eisendrath and Strauss, in which they give statistics on this subject from the Chicago dissecting rooms. These agree closely with those given by Quain and generally recognized by anatomists.

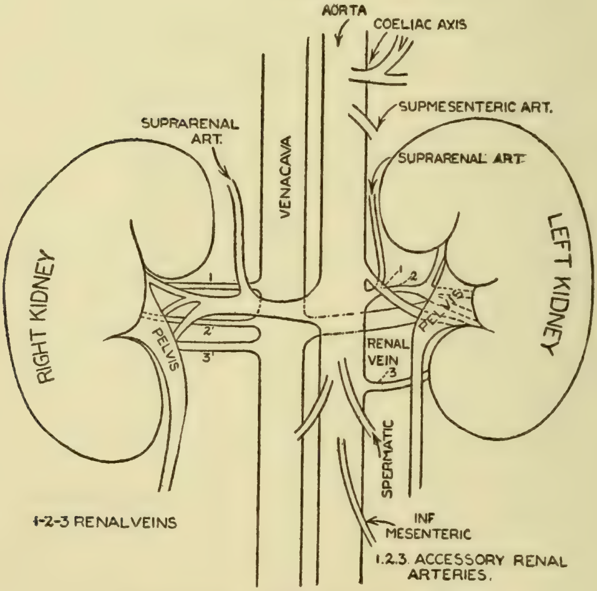
An examination of the endings of these anomalous branches indicates that they carry an important blood supply. In each instance the vessel gives off a considerable tuft of branches inside the capsule. Injection material, ultramarine blue and shellac in methyl alcohol, was always found in these branches and in the neighboring tissue. I was unable to determine the relationship of these branches to the main supply at the hilum, and the literature at my disposal gives no additional light on the subject.



Anomalous renal arteries described in Case I.

Our anatomical concepts are usually formed on the authority of some one or other of the standard texts. Such pictures we are prone to apply to any and all subjects as constant structures. Even a limited experience in the dissecting room is sufficient to convince one that the standard type is often modified in important particulars. A study of the more common variations is nearly as important as that of the general type. Most of the better anatomical texts give ample descriptions and explanations of the more frequent abnormalities. The works on operative surgery, however, give little or no space to some of them at least.

No.II



Anomalous renal vessels described in Case II.

The accepted picture of the blood supply to the kidney is that of a paired renal artery, one to each kidney. Each artery divides, close to the kidney, into three or more branches, some passing in front of the pelvis and some behind. The pedicle consists of a single artery, vein, and ureter. Besides we may also think of several small arteries entering the capsule from the parietal branches. Variations of greater or less importance are described by anatomists as being present in about 20 per cent. of all subjects. These may be considered under one of three types: 1. The renal artery, instead of being a single vessel from the aorta to the hilum may give one or more branches near the aorta. Such a branch may enter the hilum with the main blood supply or may enter at either pole of the kidney, and may pass either behind or in front of the ureter. 2. There may occur one or more true supernumerary renal arteries from the aorta, either above or below the main branch. This extra vessel also may enter the hilum or either pole of the kidney and may pass in front of or behind the ureter. Such a vessel is more common on the left side and above the main renal. According to Quain they are found in more than 3 per cent. of all cases and rarely four or more such branches occur. Accessory renal arteries of considerable size may come off from the parietal branches, inferior phrenic, or lumbar arteries, or from the spermatic or suprarenal vessels. These branches most frequently enter directly into kidney substance through the capsule. 3. When the kidneys are abnormal in position or shape, as horse-shoe kidney, etc., an abnormal blood supply is commonly found. The main arterial supply may come off the aorta as a single or multiple branch, above or near the bifurcation, from the inferior mesenteric, common or external iliac, or more often from the internal iliac artery.

Anatomically such variations are well recognized by such authors as Poirier, Sharpy, and Cuneo, Quain, Piersol, Gerrish, Sabotta-McMurrich, Treves, Deaver, and others. Practically they are of importance in two respects: first, as cause of unexpected hemorrhage complicating operations on the kidney; second, as a possible factor in the development of hydronephrosis, by causing pressure on the pelvis or ureter.

The frequency of such aberrant and abnormal vessels should be constantly in mind when operating on the kidney or ureter, and would seem to demand considerable attention in works devoted to operative surgery. Whenever the kidney is found abnormal in position or shape, aberrant and accessory branches should be expected, either at the hilum or entering the capsule. With a normal kidney such vessels are more dangerous because usually unexpected. They may be obscured by adhesions and thus injured without knowledge of their presence, or may be missed in clamping or ligating the pedicle, thus being a possible source of serious hemorrhage. Accessory and abnormal renal veins are even more common than such arteries and are an occasional source of venous hemorrhage. Works on operative surgery give scant or no attention to such possibilities in describing operations on the kidney. White and Martin, Keyes, DaCosta, Fowler, Binnie, Bickham, "International Text-book," and Keen make no mention of the possibility. Bryant speaks of irregularity in the blood supply and gives an illustration showing an accessory renal artery entering the hilum. Jacobson and Steward, speaking of causes of death after nephrectomy, mention hemorrhage, where the pedicle is short and difficult to control or where there are aberrant renal vessels.

The relation of such aberrant vessels to dilation of the pelvis and ureter is a disputed one. Mayo[2] reports that in twenty-seven cases of hydronephrosis anomalous renal vessels were present in twenty, and an obstruction was found in the ureter at the site of its relation to the vessel. In thirteen of these cases simple division of the vessel in question was sufficient to relieve the condition. Seventy-five per cent. of these vessels passed in front of the ureter. Dr. McCarthy in the same journal gives some interesting drawings which show the relation of the abnormal artery and the dilated pelvis. Gardner[3] gives an exhaustive discussion of the subject of hydronephrosis, and considers the relationship of abnormal vessels in great detail. He cites three mechanisms by which such vessels may be presumed to cause hydronephrosis by compression of the pelvis or ureter: 1, intermittent pulsation of the artery; 2, continuous pressure by the vessel; 3, actual kinking of the ureter on such a vascular cord.

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[2] Journal A. M. A., May 1, 1909.

[3] ANNALS OF SURGERY, October, 1908.

Dr. Gardner believes, however, that in many of the cases of hydronephrosis the aberrant vessel is not the primary cause of the condition. The drawings in both articles show a close relation between the vessel and the dilated ureter and pelvis. But they do not prove that the vessel caused pressure on a normal ureter, forming a stricture and dilatation. In fact, it is hard to see how such a vessel could affect a normal ureter or pelvis of a normal kidney in its usual position. Some go so far as to state that it is only because of the hydronephrosis that the vessel comes in relation with the ureter at all. There are, however, numerous cases of hydronephrosis where the aberrant vessel is the only apparent cause, and the relation must be recognized as one possibly of importance. One of three associated factors might be involved and with such a vessel lead to further changes in the pelvis or ureter. First, if there was a dilatation from any cause, such a vessel coming in relation to the dilated ureter might cause an angulation or stricture and represent the beginning of a hydronephrosis as shown in some of the drawings. Second, inflammatory adhesions about the pelvis or ureter might be a factor with an aberrant vessel in causing dilatation of the ureter above a stricture. Third, mobility of the kidney may become an important factor. In a simple nephroptosis the ureter might form a kink over an aberrant vessel passing behind it and a subsequent dilatation develop above such a point. This could hardly happen if the vessel were in front of the ureter unless the kidney were to fall forward over the vessel and rotate on its pedicle.

The embryological explanation is interesting though not absolute. Kollmann, McMurrich, and Piersol describe the mesonephros as a segmented structure receiving a series of arterial branches from the aorta. The permanent kidney develops about outgrowths from the upper end of the ureter in differentiated mesenchyme which gives rise to the glomeruli and vascular part of the kidney, at least. It is probable that this tissue also receives several branches from the aorta in the early stages of development, and that the single renal artery is the result of fusion and obliteration of the extra branches. On such a basis it is easy to understand that variations as described simply represent an incomplete development, so that supernumerary vessels and high divisions of the renal must be very frequent. The truly aberrant vessels from the inferior mesenteric, spermatic, iliacs, etc., are doubtless explained as adaptation on account of abnormal position of the kidney and are a necessary accompaniment of such a condition.

# THE ANATOMY AND TREATMENT OF UNDESCENDED TESTIS; WITH ESPECIAL REFERENCE TO THE BEVAN OPERATION.*

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The quest of an efficient method of replacing the undescended testis within the scrotum has afforded abundant exercise for the ingenuity of surgeons, especially within the past decade or two. It is a barren year, indeed, when no new operation for undescended testis is published, and the galaxy of methods that we now possess is ample testimony that this field of surgery at least has not been neglected. This extraordinary inventive activity is in itself an indication of dissatisfaction with the methods previously recommended, and my own experience corroborates this entirely. Up to within a few years I tried nearly all methods that appeared to me to be rational, but when I viewed my ultimate results, my feelings never even approached that of satisfaction. Since then, however, my experience with the Bevan operation in eighteen cases has given me results so immeasurably superior, that, from my point of view, a satisfactory operation for undescended testis has at last been attained.

This operation involves so many anatomical and physiological problems, that I shall survey these before reporting to you my clinical experiences.

The cause of the descent of the testis is a matter of academic importance, and I therefore shall refrain from discussing it at length. Moreover, there is even now no unanimity upon the matter. Of far greater importance is a correct knowledge of the anatomy of the imperfectly descended testis.

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* Read before the New York Surgical Society, October 12, 1910.

## ANATOMICAL VARIETIES.

Before I enter into a description of the anatomy of the parts in question, I must digress somewhat, in order to give a clearer definition of the abnormality under discussion. As will be seen, there are a number of varieties, and the anatomy of the parts is modified to a certain degree by the particular anomaly.

I. Non-descent.—Without going at length into embryological details, I would merely recall to you, that the primary genital anlage is placed in close proximity to the kidney, and before reaching its ultimate resting place in the scrotum it must pass along the posterior abdominal parietes and through the inguinal canal and upper parts of the scrotum. The testis may be arrested in any part of its course, and in consequence we may have the following anomalies:

1. *The abdominal non-descended testis.* The testis is arrested proximally to the internal inguinal ring.

2. *The inguinal non-descended testis.* The testis is arrested in the inguinal canal.

3. *The pubic non-descended testis.* The testis is arrested just distally to the external inguinal ring, *i.e.,* in front of the pubis.

4. *The upper scrotal non-descended testis.* The testis is arrested in the upper part of the scrotum.

II. Maldescent.—This variety differs from the preceding one in the important fact that the testis is not arrested anywhere in its course. The organ is extruded through the external inguinal ring, just like a normal testis; at this point, however, it fails to take its proper course into the scrotum and is deflected into other directions. When this occurs we may have the following three types of maldescent:

1. *The inguinosuperficial maldescended testis.* The testis, after its extrusion from the external inguinal ring, is deflected upwards and outwards, so as to lie upon the aponeurosis of the external oblique, between it and the deep layer of the

superficial fascia. I have operated upon quite a number of this variety.

2. *The crural or cruroscrotal maldescended testis.* The testis lies in the upper part of Scarpa's triangle, or more frequently in the angle formed by the thigh and scrotum. Of this variety I have operated one case.

3. *The perineal maldescended testis,* in which the testis, after its extrusion from the inguinal canal, migrates into the perineum. I have seen two instances of this variety.

### SURGICAL ANATOMY.

I have operated upon a considerable number of cases during the past twelve years, have made careful observations and notes in all, and shall endeavor to briefly place these before you. They have, I believe, a definite value, because they are not speculative; on the contrary, they are actual findings which bear very readily corroboration.

1. *The body of the testis* is usually small, at most from one-third to one-half as large as its corresponding fellow, or as large as it should be for the age of the affected individual. In consistency the organ is distinctly softer than normal, but it retains absolutely the so-called "testicular feeling." This feeling is very important in the diagnosis of the position of the testis, particularly when the anomaly is accompanied by a large omental hernia. In a great majority of the cases the testis has a distinct mesentery, allowing considerable mobility, particularly in a lateral direction.

2. *The epididymis* is, as a rule, well developed, but is not infrequently separated from the body of the testis.

3. *The vas deferens is always of ample length.* I cannot lay too great emphasis upon this point, because it has an important bearing upon the operative procedure. In fact, in many instances, the vas deferens is of unusual length and is found extending to the bottom of the scrotum, in the form of a loop, although the testis and epididymis may be situated within the inguinal canal or even within the abdomen.

In regard to this point, I would take emphatic exception to a recent statement of Katzenstein,[1] that the failures of most operations for cryptorchismus are due to the fact that the very elastic and short vas deferens retracts the testis, after it has been anchored in the scrotum. He attempts to prove his theory by attaching weights to equal lengths of spermatic vessels and vas deferens, isolated from a spermatic cord. No one doubts that this experiment will prove the well-known greater elasticity and resistance of the vas; but it would be utterly fallacious to deduct from this experiment, either that the vas is too short or that it is the cause of failures after operation.

4. *The processus vaginalis* is, as a rule, in open communication with the general peritoneal cavity, thereby converting the sac into a precursor of a so-called " congenital " hernia. I ought to make this statement with some hesitation, because a colleague has told me of a case in which there was an undescended testis, with a perfect tunica vaginalis and no accompanying hernia. Personally I have, however, never seen such a condition.

The nearest approach to such a condition came under my observation recently. The testis was high up in the inguinal canal and was accompanied by a large hernia of the congenital type. There was another sac in the scrotum, which contained a moderate amount of clear serum; the upper sac was invaginated into the lower one. In other words, the hernia corresponded more to what is termed the " infantile " type.

In approximately one-half of the cases, particularly in those accompanied by large herniæ, the vaginal process extends to the bottom of the scrotum. I wish to lay emphasis upon the point, that in about one-half the cases the vaginal process does not extend to the bottom of the scrotum, because it indicates a divergence between the observations of the embryologist and of the surgeon. The embryologist claims that the testis is always preceded in its descent by an outgrowth or prolongation of the peritoneum into the scrotum. Were this the case, we should have no trouble in demonstrating this prolongation in every case of undescended testis. As a matter of fact, we do not find it; at all events, I have never found it except in cases that are accompanied by a scrotal hernia of considerable dimensions. I believe that in these cases the prolongation was pushed to the bottom of the scrotum by the advancing hernia and was not a pre-existing entity.

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[1] Zentralblatt f. Chirurgie. No. 31, 1910.

Much stress has been laid by some surgeons upon the vaginal process as an obstacle to the bringing down of the testis at operation. I believe this theory is erroneous for the following reasons: (1) It does not take into consideration the different lengths of the sac. (2) The testis is in reality a retroperitoneal organ, and its motility cannot, therefore, be affected by something outside of it. (3) Even when the neck of the sac is freed and ligated, the testis is no nearer to the bottom of the scrotum than before. (4) The most practical of all, I have never found the sac to give me the slightest difficulty in mobilizing the testis.

The peritoneum forming the vaginal process, even when accompanied by old and large hernia, is exceedingly thin and delicate, requiring extremely careful and cautious dissection in order to liberate it.

5. *The spermatic cord* is not gathered into a normal cord-like structure, but is spread out fanshape over a considerable area. The vas, as a rule, lies somewhat isolated from the other component parts of the cord. The spreading out of the structures and the already mentioned thinness of the serous membrane make the dissection and freeing of the sac a step of unusual delicacy.

6. *The spermatic vessels* are poorly developed. Both the veins and the spermatic artery possess a smaller calibre than normal. When the spermatic artery is cut, the bleeding is slight, or at all events not nearly as free as in a normal case. I am also of the opinion that the small size and softness of the testis is due to this hypoplasia.

I now come to one of the most important observations in regard to the surgical anatomy of non-descended testis. It is this: *the spermatic vessels are deficient in length,* and apparently by the distance between the testis and the bottom of the scrotum. Whether this shortness is due to a congenital hypoplasia, I am not prepared to say. It would also carry me into the realms of speculation were I to decide off hand the question, whether the non-descent of the testis is due to the shortness of the vessels or whether the shortness of the vessels is caused by the non-descent of the testis. Arguing by analogy, similar anomalies have been noted in malpositions of other organs, *e.g.,* malpositions of the kidney; and while I have no absolute proof, I am inclined, for want of a better theory, to assume that the non-descent is in a great measure due to the shortness of the spermatic vessels.

It is also needless to add that at this time I speak only of the undescended testis, for in the maldescended organ the blood-vessels are of sufficient size and length.

7. *The scrotum* varies in size; this variation, I have found, depends upon the presence or absence of a hernia. If no hernia is present, the scrotum is very small; but if a hernia is present, the scrotum is large, its size varying with the size of the hernia. Some writers lay considerable stress upon the non-development of the scrotum, both as a cause of the non-descent of the testis and as a cause of the inability to anchor the testis properly. I am positively of the belief that both these assumptions are erroneous; first, because the scrotum accommodates itself easily to any size, either by a hernia, or by the replacing of one testis, or by the replacing of even both testes; and second, because the embryological development of the scrotum is independent of that of the testes.

There is not much to say of the anatomy of the maldescended testis. The gross anatomy is like that of the normally descended testis. Exceptions are to be noted mainly in the regional anatomy. Very frequent also is the presence of a congenital hernia. Above all, it is to be recollected that the cord as a whole and integrally is never too short, and after being freed from the surrounding structures, there is never any difficulty in transplanting or retaining the testis in the bottom of the scrotum.

### REASONS FOR OPERATING.

1. Every undescended testis is accompanied by a hernia, either actual or potential. Furthermore, in these herniæ, the application of a truss is either impossible or painful. The use of the forked truss has in my hands not proven serviceable.

2. The undescended testis is more subject to trauma than the normally situated testis.

3. It is important to remember that the testis possesses two functions: (*a*) the elaboration of spermatozoa, (*b*) the maintenance of sexual characteristics. In undescended testis the burden of belief seems to be that the spermatogenetic function is either totally absent or reduced to a minimum. This has been ably proven by Haines, who showed in a convincing study that in pigs, in whom undescended testes are very common, the spermatogenetic cells are all absent. On the other hand, he showed that the interstitial and Sertoli cells, which he believes bear important relations to the maintenance of sexual characteristics, are preserved and are enormously increased in number. The preservation of the second function is therefore a paramount indication for a conservative operation upon an undescended testis, especially in the young.

4. Although it is claimed by many that the replacement of the testis within the scrotum restores its spermatogenetic function, I have not been able to convince myself of this entirely. In one case, in which I replaced both testes, spermatozoa were absent both before and after operation. However, even the possibility that the spermatogenetic function may be restored is, to my mind, an indication for operation.

5. The not infrequently observed development of malignant tumors in non-descended testes should be considered as an indication for operation. I have seen one instance of this.

6. An undescended testis is peculiarly liable to certain accidents, which may frequently threaten and destroy its life. I refer particularly to torsion of its spermatic cord. I have operated upon three cases of this nature, in two of which I was compelled to ablate the testis at the primary operation; in

the third case I made an attempt to untwist the cord and preserve the testis, but was unsuccessful and had to ablate it at a second operation. De Quervain describes a peculiar accident in an undescended testis, by which either the body of the testis or its cord becomes strangulated by the pillars of the external ring. I have never seen a case of this nature.

7. Extension of a gonorrhœa to a scrotal testis or metastatic involvement in mumps is sufficiently distressing, but these conditions in an undescended testis are very grave and may even menace the patient's life.

8. A minor reason, perhaps, and yet not a negligible one, is the psychic depression under which adults suffer when only one, or worse still, when neither testis is in the scrotum.

There is no contraindication, except perhaps extreme youth. This, however, merely implies a postponement of the operation to a suitable age. Personally I have decided upon the age of three as the lowest limit, and postpone operation in all younger cases, unless forced to operation by strangulation or other accidents.

## TREATMENT.

First of all, I wish to emphasize that I do not regard a case of undescended testis as cured unless the testis is at the lowest part of the scrotum. I have had shown to me cases of so-called "cure" of an undescended testis, in whom the testicle was sometimes even as high as the upper third of the scrotum or front of the pubis. To call such cases "cures" is, to my mind, an evidence of a deplorable sense of satisfaction.

In view of the fact that I successively tried nearly all methods of treatment that have been recommended, a short résumé of my experiences may perhaps prove of some value. I shall try to demonstrate why these methods have largely been failures in my hands, and why I have finally settled upon the Bevan operation as the most satisfactory of all.

1. One of the first methods of treatment for undescended testis was that advocated by Langenbeck. This consisted in massage, manipulations, and the application of a forked truss,

to prevent the testis from slipping back. I have tried this method faithfully in a number of cases, where for justifiable reasons I could not operate, but with the exception that the testicle may in favorable cases be retained outside of the inguinal canal, I have seen no benefits from this method. The truss causes much discomfort and retains the hernia but unsatisfactorily.

2. The objections to orchidectomy are so apparent that I shall not even mention them. I may add, that in former years I also was guilty of performing this operation.

3. Replacement of the testis within the abdomen, with closure of the internal inguinal ring, has been suggested and carried out. With the exception of the fact that it cures the hernia, I can see no advantage in this operation over non-interference, inasmuch as it exposes the testis to all the other dangers inherent to the non-descended organ, and is certainly not cosmetic.

4. On the theory that the non-descent of the testis was due to a shortness of the vas deferens, I attempted in one case to lengthen the vas by unravelling it from the epididymis. I have not looked up the literature upon this point and do not know whether anybody has tried it before or after me. The result was a complete failure. The theory, I have since learned, was based on a misconception, and I am now convinced, as I have said before, that the vas is always of ample length.

5. Schüller's operation.[2] Early in the study of the pathology of undescended testis, the presence of the open tunica vaginalis was regarded as the cause of the non-descent. The destruction of this peritoneal prolongation was therefore considered as imperative. As advised by Schüller, this was done by dividing the tunica at the internal inguinal ring, forming a new tunica vaginalis from the lower part, and anchoring the testis to the scrotum by sutures. This operation has in my hand succeeded in a small number of cases, but only in those in which the testis is already very close to the scrotum; in

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[2] Zentralblatt für Chirurgie, 1881.

other words, in milder forms of the affection. In more aggravated cases, however, when even the slightest tension upon the cord becomes necessary, either one of two things happens: the testis tears loose from its anchorage in the scrotum and retracts to its original position; or if the anchorage holds, the scrotum gives way and is invaginated and pulled up by the retracting testis. In order to obviate this, the method has undergone numerous modifications.

(*a*) The fascial structures of the cord were sutured to the pillars of the external inguinal ring (Dowd, Kocher).

(*b*) The septum scroti was incised, and the undescended testis sutured to its fellow of the opposite side.

(*c*) The testis was anchored to the bottom of the scrotum by sutures passed through the latter, and tied over an external pledget of gauze.

(*d*) Lanz's operation.[3] Sutures were passed through the testis; these sutures were then passed through the scrotum, left long, and fastened to a wire cage or to thigh, or, according to some, even to the big toe; the idea being that the continuous traction will so lengthen the cord that upon removal of the sutures the testis will stay in the scrotum. Ingenious as this idea appears, I have seen two recurrences after this operation.

(*e*) A small incision is made in the bottom of the scrotum, through which the testis is extruded; the incision is closed snugly, leaving the testis outside, the idea being to leave it there until adhesions have formed, whereupon the incision is reopened and the testis replaced. The objections to this method are, (1) the dangers of infection, and (2) the uncertainty of the result.

(*f*) Starr[4] fastens the testis to a wire splint, which is fixed on one end to the pubic bone and at the other to the scrotum.

(*g*) Keetley-Torek. This operation is divided into many steps, consisting in a great measure of very delicate manipulations and complicated sutures. I shall not describe the operation in detail, but in essence it consists of the following steps:

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[3] Zentralblatt für Chirurgie, 1905.

[4] ANNALS OF SURGERY, vol. xlviii.

The testis is liberated and the hernia corrected. An incision is then made in the bottom of the scrotum, through which the testis is extruded. At a properly selected place an incision is then made upon the thigh, down to the fascia; the testis is fastened to this structure, and the two lips of the scrotal incision are sutured to the two lips of the thigh incision. The principle of the operation consists in the belief that the fixation of the testis to the thigh lengthens the cord. At a second operation, from three months to a year later, the scrotum and testis are liberated from the thigh, and the testis replaced within the scrotum.

Excluding the technical difficulties, which, to my mind, are minimized by the originators of the operation, the operation possesses a number of objections. The postoperative course is not a very pleasant one for the patients; they object to the continuous dragging upon the testis; and after the wounds have healed, their gait is worse than awkward; they are troubled for a long time with a disagreeable eczema from the apposed skin surfaces, particularly in hot weather. The danger of infection is not small, and, finally, the necessity of performing two operations is not to be considered too lightly.

For the sake of completeness, I may add:

6. Beck's necktie operation,[5] which at best can only hold the testis outside of the external inguinal ring.

7. Kirschner's operation[6] was published this year, and only goes to prove that the possibilities are by no means exhausted. A sort of bell-shaped receptacle is made for the testicle, from a piece of the fascia lata of the patient (autoplastic), which is passed through a subcutaneous tunnel and is fastened to the superficial perineal fascia.

8. Bevan's operation.[7] When I read Bevan's original report, I was at first inclined to be sceptical, believing that the division of such important parts of the spermatic cord must surely result in gangrene of the testis. Bevan's report, how-

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[5] N. Y. Medical Record, Aug. 12, 1905.

[6] Langenbeck's Archiv., vol. xcii, p. 906.

[7] Langenbeck's Archiv., vol. lxxii, p. 1035.

ever, was so reassuring, that I determined to try the operation. Since then I have never had occasion to regret my decision.

Before explaining to you the principles upon which the operation is based, I shall describe the operation in detail.

1. The cutaneous incision is like that for the radical cure of inguinal hernia. The aponeurosis of the external oblique is split in the direction of its fibres. Retraction of the lower flap exposes Poupart's ligament.

2. The hernial sac is now isolated and freed from the spermatic cord. It is advisable to begin the isolation of the sac at the neck; when this is done, the peritoneal cavity is closed, either by transfixion and ligation, or by circular suture. It is perhaps needless to add, that when the testis is intra-abdominal, it is essential to first open the sac and extract the testicle from the abdomen. I have never seen the occasionally described adhesions between the testis and the peritoneum, due, as some authors claim, to a fetal peritonitis, which in turn was supposed to cause the non-descent of the organ.

The distal part of the sac can be dealt with in three different ways: (*a*) it may be cut off close to its attachment to the testis; (*b*) it may be cut off at some distance from the testis, and a new tunica vaginalis formed; (*c*) it may be everted and sutured. I have used all three methods, and have obtained equally good results with all. I prefer the first method, because it saves time by not requiring any sutures.

In isolating the sac there is one very important point to be observed. The liberation of the vas deferens from the sac must be carried out with exceeding care. The vas deferens should never be handled roughly, and should certainly never be pinched with forceps. The ultimate viability of the testis depends, as will be shown later, upon the small artery of the vas, a branch of one of the vesicals, and if this should be injured or thrombosed there is a grave danger of necrosis of the testicle.

3. If the parts are now examined, there will be seen the vas deferens with its vessels, and the spermatic vessels, diverging as they enter the internal inguinal ring; the former going

downwards and inwards toward the bladder, the latter almost directly upwards and slightly inward.

The cord is now gauged as to whether or not it will permit transplantation. In minor degrees of non-descent, transplantation may be possible. If it is impossible to bring down the testis, traction upon the cord will readily show that the spermatic vessels become taut, and not the vas deferens.

In some instances freeing the vessels of all extrinsic fascial structures, by teasing and occasional snips with the scissors, will enable the testicle to be brought down. In most cases this will not suffice, and we have to proceed to the essential part of the Bevan operation, namely, the division and ligation of the spermatic vessels.

The moment this is done, it will be seen that no matter how high up the testis may have been situated, there is not the slightest difficulty in bringing the testis down to the very bottom of the scrotum, particularly if the vas is freed down to the epididymis.

4. The corresponding half of the scrotum is now stretched with the finger or dressing forceps, for the accommodation of the testis. There is never any trouble with this step, no matter how small and how shrunken the scrotum appears to be. Into the pocket thus formed the testicle is placed without any anchorage, and in order to prevent any possible luxation, the neck of the scrotum is closed around the vas by an interrupted or circular suture.

5. The radical operation for the hernia is now proceeded with, without any transplantation of the vas. In some instances I have adopted the Fowler operation, which diminishes the arc of the spermatic cord. In one instance I tried to gain space by liberating the deep epigastric vessels and slipping the testis behind the vessels, before transplanting the organ into the scrotum. I have found this, however, to be an unnecessary and bothersome refinement.

### POSTOPERATIVE COURSE.

Not infrequently, on the second or third day after operation, there is more or less exudation around the testis. Whether this is due to an infarction, or thrombosis, or to a diminished return flow, I am not able to say definitely, for the simple reason that I have never had occasion to reopen the wound. Under the application of a hot water bag, this exudation, however, quickly becomes absorbed. In my earlier cases I rather dreaded this œdema and feared interference with the blood supply, but I have now become accustomed to it.

## RATIONALE OF BEVAN'S OPERATION.

Bevan devised his operation upon a correct knowledge of the blood supply of the testis, and upon the important discovery, as I have already emphasized, that the inability to bring the testis down into the scrotum was due to the shortness of the vessels of the cord.

For a long time it was assumed (Miflet[8]) that the spermatic artery is an end artery, and that it is the sole arterial supply of the testis. Recent investigations (Griffiths[9] and Hill[10]) have, however, shown that this is an error, and that the testis has an additional and very important blood supply, namely, the artery of the vas deferens, a branch usually of one of the vesical arteries.

In order to prove this to my own satisfaction, from a physiological view-point, I performed a series of experiments on dogs at the Pathological Laboratory of the College of Physicians and Surgeons, through the kindness of Professor MacCallum. I divided the spermatic vessels, leaving the testicle *in situ,* and removed the testes at periods varying from four days to three weeks after operation. The testes were examined histologically. In no instance did gangrene occur. Microscopically, some of the testes, especially the earlier ones, showed some necrosis in the interior of the testis, but around the periphery the alveoli presented a fair state of preservation. Upon second thought, I have come to the belief that I removed the testes too soon after operation, not permitting sufficient time for regeneration. While my experiments are therefore not entirely convincing in affording a proof of perfect preservation of the testicular tissue after ligation of the spermatic vessels, they do prove the important point, namely, that the testis does not become gangrenous. When we consider that undescended testes, as shown by Haines, are in all probability non-spermatogenetic, the problem after all, whether the alveoli of the testis are destroyed or not, is a matter of small consideration.

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[8] Langenbeck's Archiv., vol. xxiv.

[9] Journal of Anatomy and Physiology, vol. xxx, p. 81.

[10] American Journal of Anatomy, 1909, p. 463.

If further proof were wanting, the results of the Bevan operation speak for themselves. In no case of my series did necrosis of the testicle occur, and the preservation of erectile power is, to a certain extent, proven by the maintenance of perfect *potentia cœundi* in one adult case of bilateral undescended testes which I operated.

## RESULTS.

I have operated on eighteen patients by the Bevan method. Fourteen were operated at Mount Sinai Hospital, and four at the Har Moriah Hospital. Inasmuch as four were bilateral, I have performed the operation twenty-two times. The first case was operated upon July 26, 1905, the last case in August, 1910. I have kept most of these cases under continuous observation, and I may add that with the exception of my second case, in which the testis is even more atrophic than at the time of the operation, the final result is more than satisfactory. Primary union resulted in every instance; there is no recurrence of the hernia; the testis is freely movable and in the very bottom of the scrotum. In other words, all these patients can be legitimately regarded as completely cured, as far as the descent of the testis and the hernia is concerned. I do not believe that any other operation for undescended testis can establish a record comparable to this.

The purpose of this paper is therefore an advocacy of the Bevan operation. I do this not only from a sense of pleasure over the results that it has afforded me, but also because the operation, if the infrequency with which the operation has found its way into the literature is a criterion, has thus far found few adherents.

# RESECTION OF THE MALE RECTUM FOR CANCER, BY THE COMBINED METHOD IN TWO STAGES.*

## FIRST STAGE UNDER SPINAL ANÆSTHESIA.

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A MAN, age twenty-seven years, machinist by trade, had mucous discharges from the bowel for six months prior to operation, with passage of blood only two or three times. He had lost about twenty-seven pounds in weight. In the anterior wall of the rectum, was a tumor whose lower limit was between one and a half and two inches above the upper margin of the internal sphincter, while above, it reached to the anterior valve of Houston. It measured transversely from about one and a half to two inches. A microscopic diagnosis of adenocarcinoma was made.

Wishing particularly in the case of this very young man to preserve the normal bowel control which would enable him to continue unhandicapped a life of usefulness, it was concluded to perform, if possible, resection of the rectum. To determine whether or not resection could be accomplished, it was quite essential that the abdomen be first opened, to ascertain, first, whether the tumor was adherent to the base of the bladder, and second, whether the sigmoid flexure above the disease was capable of sufficient descent to re-establish the continuity of the bowel.

Perhaps the greatest objection to attempting resection of the rectum is the prolonged anæsthesia needed for its accomplishment. It was reasoned that if spinal anæsthesia could be utilized for the abdominal portion of the operation, then the rest of the operation through the posterior route could be done under ether at a second sitting on the following day, and the period of ether anæsthesia thus considerably shortened.

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* Case presented before the New York Surgical Society, Oct. 12, 1910.

The administration of spinal anæsthesia in a way to secure analgesia of the abdomen has been scientifically worked out by Barker,[1] who employs therefor a particular posture of the patient and as anæsthetic a stovaine-glucose solution having a specific gravity much heavier than that of the spinal fluid. The patient is placed in Barker's position by laying him on his side on a flat table with his hips elevated on a block one inch thick, and his head and neck raised as nearly vertical as possible. This posture throws the spinal column and cord into a position of lateral curvature, the most dependent point of which is about the mid-dorsal region, to which level the specifically heavy stovaine-glucose solution gravitates when injected at the midlumbar region, and exercises there its paralyzing effect on all of the cord below. The head and neck are elevated so as to keep the locality of the foramen magnum beyond the reach of the specifically heavy stovaine solution. The elevation should be maintained for a time following the operation. When the patient is turned on the back the locality of the dependent point in the spinal curve is not materially altered. If the patient remains on his side, analgesia is confined to the side on which he is lying. In manœuvring to secure as much Trendelenburg position as possible for use in this case without too much lowering of the head, it was found that by raising the foot of the table so as to incline the latter about 4 degrees, and then placing the hips on a sand pillow about one and a half inches in thickness, the head and neck being at the same time propped almost upright, the foramen magnum still lay well above the level of the dorsal dip. This posture was therefore employed both for the lateral position during the administration of the injection, and afterward for the dorsal position as well, to which latter, in order to allow the pelvis to tilt forward, there was added the support of the thighs in the flexed position by sand bags and pillows beneath the knees. It was found at operation that this dorsal posture fulfilled all the requirements of the Trendelenburg position. It can be seen that spinal anæsthesia for the second stage of this operation, at least with the use of a specifically heavy anæsthetizing solution, would be contraindicated, on account of the necessity in it of lowering the patient's head while anastomosing the bowel ends.

The patient was prepared for operation by the administration of castor oil on the preceding third and second nights, followed on the day and night immediately before operation by enemata, which were repeated until the abdominal wall was a little retracted, and the administration of deodorized tincture of opium.

Except for the two-stage feature, the operative procedure in this case of resection of the rectum was quite similar to that in another case already illustrated by the writer.[2]

*First Stage,* June 24, 1910.—Spinal anæsthesia was administered in the lateral posture, and right afterward the patient was placed in the dorsal posture, as above described. The puncture was made between the second and third lumbar vertebræ, about 10 c.c. of spinal fluid were removed as a preventative against vomiting and headache, and then 0.06 gramme of stovaine * was injected. Complete analgesia up to a level about two inches above the umbilicus was quickly produced and lasted just 50 minutes. The abdominal wall was perfectly relaxed. The analgesia terminated abruptly, and the pain for the remainder of the operative procedure was deadened with a surprisingly small amount of chloroform. The abdominal operation lasted 1¼ hours. It took a few minutes longer to effect the posterior drainage opening. The operative steps were as follows: Median abdominal incision. The prerectal space was first opened up presenting a normal cleavage between rectum and bladder, thus establishing at once operability. The sigmoid flexure was estimated to be capable of sufficient descent to permit of resection, there seeming to be a sufficiently long sigmoid loop with a mesosigmoid of a proper anatomical formation to permit the piece of bowel above the disease, after being freed by division of the mesosigmoid proximal to the arterial arcades, to be brought about six inches below the left common iliac artery. The rectum was then freed behind, the internal iliac and superior hemorrhoidal arteries were isolated and tied, the lateral neurofibrous attachments of the rectum to the pelvic wall (pelvirectal attachments) were isolated and cut, thus mobilizing the remaining

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* The anæsthetic solution here used was made according to Barker's early formula, which was stovaine, 10 per cent., and glucose, 5 per cent. Later Barker used a solution containing stovaine, 5 per cent., and glucose, 5 per cent.

paraproctеal attachments so that in the second stage they could be hooked downward with the finger through the posterior wound and severed widely, and both peritoneal leaves of the mesosigmoid were cut, and two sigmoid arteries isolated and tied proximal to the arterial arcades. The left peritoneal attachment of the sigmoid was cut high in the iliac fossa and the corresponding piece of bowel stripped out of its bed to allow a maximum descent of the freed segment. The posterior lymphatics of the rectum were infiltrated up to the site of entrance into the bowel of the superior hemorrhoidal vessels. The peritoneal opening was narrowed by drawing together its edges at the upper portion of the pelvic cavity with three stitches, behind the liberated bowel. A 20-inch-long rectal tube was inserted into the bowel for the escape of wind. It did not reach quite through the entire length of the freed loop. The tube was rather stiff, and soon after finishing the operation, fearing that it might cause undue pressure on the bowel up in the iliac fossa, it was drawn down about eight inches. The deep abdominal wound was supported by three kangaroo stitches in anticipation of the ether anæsthesia to be administered on the following day. A drainage opening was finally made alongside the coccyx into the retrorectal space.

*Immediate Result.*—There was not a particle of shock. There was no nausea, headache, or abdominal distention. The patient began to drink water three hours after the completion of the operation, and was able to take it freely. He also took during the afternoon and evening twelve ounces of milk. He passed a comfortable night. The next morning just before operation the rectum was washed with a borax solution which removed considerable mucus, and the tube introduced on the previous day was withdrawn. The patient was given Magendie minims vii and atropin grain 1/50 an hour preceding operation.

*Second Stage,* June 25, 1910.—Patient anæsthetized in the position for beginning the operation, which was on his left side with thighs and knees semiflexed, starting with chloroform so that there should be as little straining as possible, and then changing to ether. There was in this way no struggling. The sphincters were then stretched, and with a gauze wipe the rectum was determined to be practically dry. An inch wide strip of gauze soaked in a chinosol solution 1 in 500, was introduced into the lower rectum and anus for their disinfection, until the time for opening the bowel should arrive. The posterior approach devised by myself[3] was utilized. This consists of a central incision which diverges at the coccyx from the median line to pass through one ischiorectal fossa, avoiding the inferior hemorrhoidal nerves, with two wide lateral cuts, the reflection of the coccyx in one of the lateral flaps, and the removal of the portion of the sacrum below the inferior lateral angles. In making the posterior incision there was free bleeding from but three or four small points in the soft parts. There was some hemorrhage in dividing the sacrum, which soon became self-arrested. There seemed to be no median sacral artery. The lateral paraprocteal attachments of the rectum were easily hooked down over the finger and severed. A middle hemorrhoidal artery lay in these structures on the right side, which on division spurted freely, this notwithstanding the preliminary ligature of the internal iliacs. The left middle hemorrhoidal artery was dissected out and tied before severance. The bowel was freed down to the upper level of the internal sphincter. A narrow iodoform strip was now passed up along either side of the bowel into the peritoneal cavity, and one anteriorly, and a temporary gauze pack was made to occupy the wound cavity to protect against infection during division of the bowel. The bowel was clamped across an inch below the tumor just above the internal sphincter, and severed close to the clamp. The severance was made according to the technic of Kraske, by interrupted cuttings and the placing of traction loops of heavy silk at intervals along the margin of the distal segment as it became freed, for the subsequent control of the edge in suturing. The patient was now put in Kraske's dorsal position, with high elevation of the hips and thighs flexed over the abdomen, for suture of the bowel ends. The bowel was sectioned above the tumor opposite the site of entrance of the superior hemorrhoidal vessels, which was just beyond the indurated posterior lymphatics. A higher division of the bowel would not have left enough to re-establish the continuity of the gut. In dividing across the mesenteric border of the descended gut, there was a marginal artery which spurted freely. The portions of the peritoneal leaves of the mesosigmoid which remained attached to the freed proximal end of bowel, causing the latter to curl a little on itself, were cut where they exercised restraint to the straightening out of the gut.

The bowel ends were sutured together for most of the circuit, with interrupted sutures of stout iron-dyed twisted silk tied on the inside, and a few chromic sutures placed externally effected the final closure. Celloidin linen thread for the inner stitches would probably be preferable to silk. A stout full-curved round needle was used. Care was taken to include serous surfaces of the proximal segment within the grasp of each stitch. The mesenteric attachment of the proximal segment lay in the posterior median line of the anastomosis, at which site serous surfaces were brought into the line of union by a Maunsell mesenteric stitch. For the avoidance of stricture, care was taken to make an even coaptation of the mucous edges, the latter being first caught with sutures (which included the edge of the serous coat of the proximal segment) at intervals at opposite points, and then by traction on any two of these adjoining stitches the mucous edges would be held evenly in apposition while deeply placed stitches, including about half an inch of either margin, were passed and tied. When the anastomosis was completed, the temporary gauze packing was removed, and a gauze strip soaked in glycerin was placed gently upward along either side of the bowel and in front of the lower portion of the sacrum. There was no drain placed near the suture line. In fact the levatores ani were drawn together directly over the posterior portion of the suture line in the hope of getting an early adhesion here with serous surface that would fortify the union. The lateral muscular cuts were each approximated with two or three chromic sutures. A small double-barrelled tube drain was inserted through the anus.

*Result.*—Recovery uneventful except for the development of a small fistula on the eighth day, which was one day before the bowels were moved. Highest temperature 101° on the seventh day. Tincture opii deodorat. administered. The patient did not suffer from abdominal distention. He expelled wind freely through the tube in the anus. On the fourth day the glycerin gauze drains were removed, on the sixth day the two lateral iodoform strips were taken out, and on the seventh day the anterior one. The interior of the bowel was syringed every day with a chinosol solution, 1 in 500, and on the fifth day the daily injection of a little olive oil was begun as well. The reflux from these syringings was practically always clear. When the bowels were moved on the ninth day, all the discharge, which was watery, came through the posterior wound. At the same time the effort to discover the fistulous track into the bowel with a probe was unsuccessful for some days. The opening, which was not large, was located anterolaterally on the right side. The patient had lain chiefly on his left side, toward which the bowel evidently sagged, thus removing the suture line on the right side from a perfect apposition with the surrounding tissues and consequently interfering with the opportunity for a supporting adhesion to form at this portion of the periphery. The leakage may, however, have been due to infection. The lateral cuts healed by primary union, as did also the abdominal wound.

The wound has gradually closed. Since the middle of September there has been no fecal leakage, and during the past ten days (prior to October 12) escape of wind through the fistula has been noticed but twice. (On November 7, the fistula had completely healed.) The sphincters functionate normally, and there is no stricture at the seat of anastomosis. The patient has regained his normal weight. (On November 7, he had gained 36 pounds.)

Dr. Crowell who examined the specimen, reported that the tumor had apparently been excised beyond the limits of the disease. Sections at three levels at the upper part of the indurated posterior lymphatics showed evidence only of an inflammatory process.

*Special Considerations.*—1. The abdominal portion of the combined operation in resection of the rectum may be done under spinal anæsthesia without any shock.

2. *Lumbar puncture* can be made a very simple procedure if the needle be introduced in a direction forward and very slightly inward just lateral to the interspinous ligament. The skin should be nicked about one-third of an inch from the median line at the site of introduction of the needle. The first deep guide is the ligamentum subflava which offers its resistance to the needle point, and next is the dura beneath it, puncture of which with a needle not too sharply pointed, can usually be felt, or may even be heard. The writer has employed this technic on occasion, always satisfactorily, for

several years, but wishes to acknowledge that a similar technic has recently been published by H. Tyrrell Gray [4] who, using the same deep guides, directs the point of the needle inward and a little upward toward the posterior median line of the dura. By this method one can be readily guided by the sense of touch, which latter, in a median puncture where the needle must traverse the dense supraspinous and interspinous ligaments, would at least have little delicacy. Gray reports that in 200 cases of lumbar puncture by the method described, he touched a nerve twice with no other ill result than momentary pain, and once in a case of fracture of the base of the skull, with resulting cessation of respiration for a considerable period of time, apparently excited by a definite movement of the needle. The writer uses a platinum needle with an extremity cut diagonally at such an angle as to make a short oval opening and a point that is not too sharp.

3. Barker brings out the fact that stovaine solutions may be boiled at 115° C. for 15 minutes without loss of potency. Another factor in the use of stovaine is, that sodium carbonate or other alkaline fluid neutralizes its action, so the injecting syringe and needle should be boiled in plain water.

4. Since in this case only just enough bowel could be liberated by the abdominal route to reunite the ends after excision of the disease, cutting the attachments upward into the iliac fossa, a resection of the bowel with end-to-end suture could not have been accomplished by the posterior route alone, much less an implantation within the denuded sphincters.

5. Since the preliminary *ligature of the internal iliac arteries* did not control the hemorrhage from the middle hemorrhoidal branches, its chief advantage in the male must be for limiting the hemorrhage in the making of a posterior or perineal approach. *Technic:* The internal iliac arteries can be very easily isolated for ligature by passing the finger beneath the fascia propria recti, locating the bifurcation of the common iliac, which is situated about one inch lateral to the promontory, and stripping with the finger, using some force, from the angle of divergence of the two vascular trunks,

downward and backward along the anterior border of the internal branch. The fascia teases through and the artery raises off from its accompanying vein. This procedure, done by the sense of touch, facilitates very greatly ligature of these vessels. It was practised in this case. For stripping the artery free, it is better to stand on the side of the patient corresponding to the vessel, but in passing the ligature, it is better to stand on the side opposite to the vessel.

6. The surgical importance of the *lateral pelvirectal attachments* [5] may well be again emphasized. The severance of these unyielding, fascial, nerve-supporting connections between rectum and pelvic wall, extending from just below the level of the ureter to the fourth sacral foramen, is very important in the mobilization of the rectum.

7. The posterior approach here employed gives a broad operative field for performing the anastomosis, affords good drainage, and is easily closed around the drainage opening. It has healed promptly in two cases where it has been used, re-establishing firm support.

8. When, in resecting the rectum by the combined operation, the bowel is divided through the posterior wound after having packed off the peritoneal cavity, and a tight anastomosis made with a complete circular suture, the danger of fecal infection of the peritoneal cavity must be *nil.*

9. If the mucous edges of the bowel ends be evenly coapted, provided union take place, there should be no stricture.

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[1] Barker: British Medical Journal, 1907, i, p. 665; and *Ibid.*, 1908, i, p. 244.

[2] Lusk: Surgery, Gynæcology and Obstetrics, ix, 1909, p. 491.

[3] Lusk: *Ibid.* and Surgery, Gynæcology, and Obstetrics, vii, 1908, pp. 205–207, 222.

[4] Gray: Lancet, 1909, ii, pp. 913, 991.

[5] Lusk: Surgery, Gynæcology, and Obstetrics, ix, 1909, p. 501.

# FRACTURE OF THE TARSAL SCAPHOID.

## WITH A REPORT OF CASES TREATED BY OPERATION.

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The treatment of two cases of fracture of the tarsal scaphoid, in the Orthopædic Department of the Carney Hospital within three months of each other, makes timely this report and a review of the literature of previously reported cases. Practically no mention is made in our latest text-books on fractures of the tarsal scaphoid other than that made by Stimson to the effect that its occurrence is rare, except with other tarsal fractures.

Fracture of the scaphoid is due usually to violence from falls, received either in forced dorsal or plantar flexion. In striking so, the scaphoid transmits the whole force of the violence.

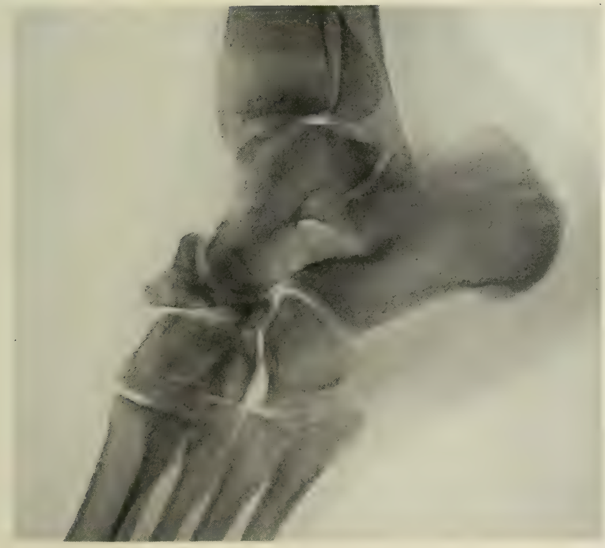
Slight twists occasionally accompanied by a Pott's fracture can result in a fracture of the scaphoid. The local sign is the swelling from disturbance of circulation and trauma, exaggerated when a dislocation of the fragment has taken place. Tenderness over the scaphoid on the inner side depends largely upon the time elapsing after the fracture.

Ankle-joint motions in flexion and extension are normal, but when forced are accompanied by pain referred to the scaphoid. The midtarsal motions are markedly restricted. The foot is held in slight eversion, and practically no inversion is possible. Both the lateral and anteroposterior radiograms will show the fracture and displacement. The treatment in these cases is conservative for at least the first few days. If the displaced fragment can be reduced and the foot held in inversion, we may expect a good functional result. If, however, this is impossible, operative treatment should be at once begun. This fracture, located as it is, and so important to the normal arch of the foot, will not permit of any laxity of treatment. The whole static mechanism of the limb is involved and is readily thrown out of plumb by an improperly reduced fragment or malunion. We believe that operative interference resorted to early, not only is safe, but insures better function and less static disturbance.

*Operative Treatment.*—This consists of (*a*) cutting down upon the fractured scaphoid and taking out the fractured portion; or (*b*) making an excision of the scaphoid *in toto,* leaving as much of the periosteum as possible in order that regeneration of bone may take place. This latter procedure is especially satisfactory, as the remaining scaphoid is usually crushed and will develop hyperplastic tissue. The new bone formed will more perfectly fit the space left when proper inversion of the foot is obtained. Following this, the foot should be inverted and placed in plaster of Paris for three or four weeks, after which the plaster should be removed and the foot held by spiral strapping. Later a light spring plate is useful to relieve the operated region from strain in weight-bearing. After six or eight weeks, baking and massage will help to increase the circulation and restore the tonicity of the foot. Passive motions should then be encouraged, and the patient given crutches. A good functional result was obtained in the two cases reported below.

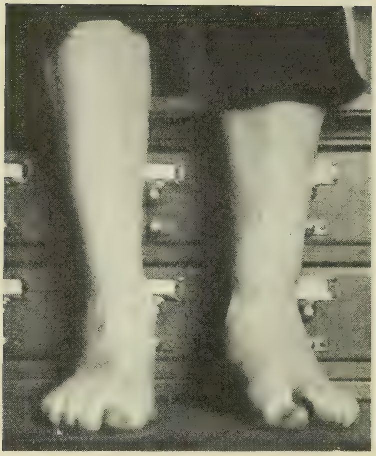
Hoffman calls attention to the rarity of these fractures, and finds only twenty-two reported in the literature. He states that diagnosis can only be positively made by the use of the radiograph. He recommends plaster dressing in acute cases and operative interference in obstinate and deformed cases, thereby leaving the periosteum to develop new bone. In the severe cases, with arthritic changes, he excised the whole scaphoid.

FIG. 1.



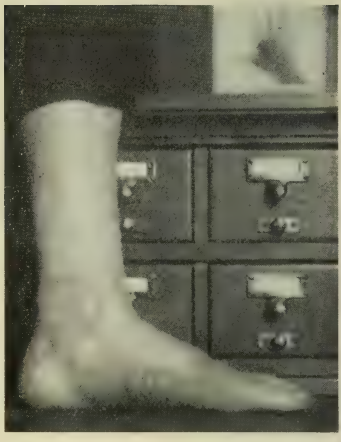
R. M. Fracture of tarsal scaphoid with dislocation of fragment. Taken before operation.

Fig. 2.



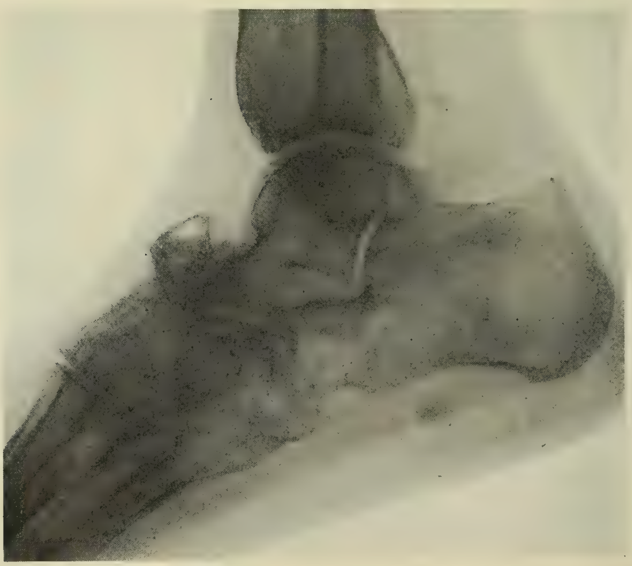
W. F. Note prominence over scaphoid and swelling.

Fig. 3.



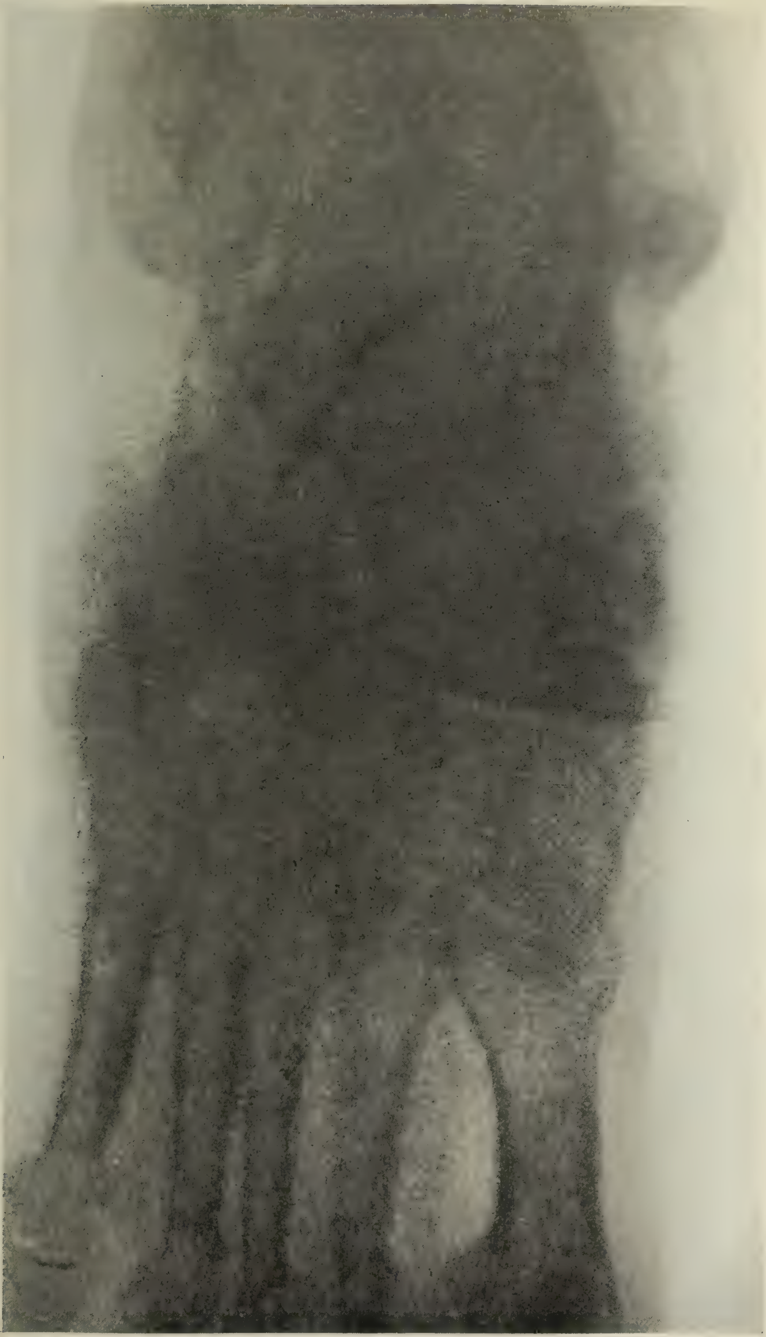
W. F. Lateral view—swelling obliterating posterior arch.

Fig. 4.



W. F. Fracture of tarsal scaphoid with dislocation of fragment. Taken before operation.

FIG. 5.



W. F. Anteroposterior view of Case II. Taken before operation.

Deutchlander states that conservative treatment is useless. This experience is corroborated by Bahr, who has excised one scaphoid *in toto,* and the displaced fragment in one other. Deutchlander's results in two cases have been good.

CASE I.—R. M., age sixteen. Patient entered the Orthopædic Department of the Carney Hospital March 2, 1909, and gave the following history:

*Family History.*—Negative.

*Present Illness.*—Six months ago fell from a door-step and at that time seemingly injured the right ankle only. Left ankle was lame but did not cause any great amount of inconvenience. Two months after, patient turned left ankle and has had pain in the region of the inner side of scaphoid ever since. Condition has gradually grown worse.

*Physical Examination.*— Left foot held slightly in a position of eversion and a prominence noted on the inner side of scaphoid. Ankle-joint motions were good. Inversion and eversion at the midtarsal joint, especially the former, limited. Tenderness over prominence corresponding to inner head of scaphoid. X-ray taken (see radiogram, Fig. 1). Diagnosis: fracture of tarsal scaphoid. Referred to House.

March 3, 1909: Ether; operation. An incision about three inches long was made parallel to the dorsum of the foot (*lt*), and over the inner side of the scaphoid. Fascia and periosteum were divided and separated from the scaphoid. The scaphoid bone was soft and there apparently was no attempt made at repair. Owing to inability to correct the foot in inversion the scaphoid *in toto* was excised.

A correct position was possible following this procedure. Chromic catgut was used to sew fascia and periosteum together, while the assistant so held the foot in inversion as to practically obliterate the cavity previously occupied by the scaphoid. The skin was closed with catgut and the foot placed in a light plaster cast in marked inversion. Good ether recovery and uneventful convalescence. March 8, 1909, discharged from House.

Subsequent treatment was removal of cast in four weeks, followed by spiral strapping and a light spring plate to support the longitudinal arch until the musculature was redeveloped. When patient was last seen functional result was excellent. Since then, has been lost sight of.

Case II.—W. F., thirty-nine years, single.

*Family History.*—Negative.

*Personal History.*—Negative.

*Present Illness.*—Five months ago fell 22 feet from a scaffold, landing mostly on left foot. Has had pain in ankle and used crutches to walk since the accident. Had strapping and bandaging without relief.

*Physical Examination.*—Left ankle prominent and enlarged over scaphoid. Ankle-joint motions limited only in extremes. Midtarsal joint motions markedly restricted and accompanied by pain referred to region of scaphoid. Considerable muscle spasm and rigidity. Foot in position of valgus, which cannot be corrected. Considerable thickening around the scaphoid. Photographs taken (see photographs, Figs. 2 and 3); radiogram taken (see radiograms, Figs. 4 and 5). Diagnosis: fracture of tarsal scaphoid. Referred to House.

June 9, 1909: Ether; operation. A semicircular incision made and the same technic followed as in the above case. Only the fractured portion of the scaphoid bone was removed. No attempt at union could be seen. Wound was closed in usual manner, and foot put up in an inverted position. Uneventful convalescence. Removal of plaster cast in four weeks. Strapping and plate used. Baking and massage were useful in attaining better circulation and function. Result: a good functional foot.

Conclusion.—Fracture of the tarsal scaphoid, although rare, may occur without fracture of other tarsal bones. In both cases swelling and tenderness existed over the scaphoid. Ankle-joint motions were normal, but a marked limitation in inversion was present and in abduction at the mediotarsal joint. Correction could not be attained by manipulation.

The scaphoid in structure was found in both cases to be a good deal like the softening occurring in old ununited intracapsular fractures of the head of the femur.

Excision of the scaphoid seems justifiable and remarkable, in that the static condition of the foot is not weakened but markedly improved in the two reported cases by this procedure. In new cases where the injury has just occurred.

the deformity occurring would suggest the foot being put in plaster in a marked varus position.

Lange, of Cincinnati, covers some of the methods of recognizing such fractures, and believes them to be more numerous since the use of radiography.

Nippold calls attention to errors in diagnosis on account of accessory sesamoids.

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# CHARLES ROBERT BELL KEETLEY, F.R.C.S.

Mr. Charles R. B. Keetley died at Brighton, England, on December 4, 1909, of heart failure, in the sixty-second year of his age. It is especially proper that the Annals of Surgery should record an appreciation of the character and work of Mr. Keetley, who was one of the founders of the Journal, and who during the earlier years of its history was a very frequent contributor to its pages, and who during his whole subsequent life remained its warmly interested friend. The first paper in the first issue of the Annals of Surgery was from the pen of Mr. Keetley. The title was "On Removal by Scraping out of the Marrow of Long Bones, and Especially on this Proceeding as a Treatment of Osteomyelitis." This paper displayed in a marked manner the peculiar characteristics of Mr. Keetley's mind,—his avidity for new truths, his readiness to accept and act upon the experience of others, and his own ingenuity and resourcefulness in the working out of new ideas. In this article Mr. Keetley struck the keynote which has characterized the Annals of Surgery throughout its entire history. Of the very elaborate Review of the Surgical Year which was published as an editorial article in the same number of the Annals of Surgery, Mr. Keetley contributed that portion of it devoted to British surgery. Mr. Keetley took a warm interest in the organization of that department of the Journal known as the "Index of Surgical Progress," and succeeded in enlisting the co-operation of a large number of his colleagues in this department, so that among the list of contributors to that first volume appear the names of Ball and Thomas of Dublin, Cathcart of Edinburgh, Chavasse and May of Birmingham, Wherry of Cambridge, Street of Westgate, and Clark, Dunn, Edwards, Eve, Fenwick, Gould, Hutchinson, McNamara, Pye, Schacht, and Weiss of London. At the special invitation of the writer Mr. Keetley contributed to the special number which concluded the fiftieth volume of the Annals of Surgery the article which concluded the issue, so that of the first fifty volumes of this Journal the first and the last of the original memoirs which appeared in its pages were contributed by this one surgeon. The final contribution of Mr. Keetley did not appear until after the death of its lamented author.

The first acquaintance of the writer with Mr. Keetley was made in 1878 in the out-patient department of St. Bartholomew's Hospital. The acquaintance then made soon ripened into a friendship which lasted during more than thirty years, until his death. It was during an after-dinner talk in London, in the spring of 1884, that the idea of a surgical journal which should comprehensively represent both British and American surgical work was discussed between us, and, as I have already mentioned, in an historical note previously published, when upon my return to New York shortly thereafter, Mr. Chambers of St. Louis approached me with a proposition for the editing of such a journal, I at once turned to Mr. Keetley for collaboration. This he gave heartily and without stint, and it has always been a great pleasure to acknowledge the indebtedness which is due from the ANNALS OF SURGERY to him for the assistance which he gave in its foundation.

Mr. Keetley was born on September 13, 1848, at Grimsby, being the son of Mr. Robert Keetley, a ship-builder of that place. He began his professional education in the Hull Infirmary, and later entered as a student at Saint Bartholomew's Hospital. As a student he received gold medals at the London University in anatomy and materia medica. After qualifying in 1873 he became house surgeon at the Queens Hospital, Birmingham. In 1876 he took the fellowship of the Royal College of Surgeons of England, and having settled in London was for some years thereafter an assistant demonstrator of anatomy at Saint Bartholomew's Hospital. In 1879 he was appointed assistant surgeon for the West London Hospital, and Mr. Stephen Paget in the course of an obituary notice published in the *Lancet* says of him:

"The true beginning of his surgical career came when he was appointed assistant surgeon to the West London Hospital. It is not too much to say that no hospital ever had a more zealous and faithful servant. From the day he first entered there to the time of his last illness he gave his mind and his strength, even with a sort of extravagance, to its advancement and welfare. During his thirty years of service the West London Hospital grew from a suburban venture to a great general hospital for a million people, to which is affiliated a great post-graduate school. Keetley's name will ever be associated with this development of the place that he loved. There is little doubt that he could have lived longer if he could have been persuaded to allow himself more rest. He was far more careful of other people's wants than of his own, and his high place in our profession would have stood even higher if he had been more businesslike in his private practice."

In the same article Mr. Paget compares Mr. Keetley with John Hunter in these words:

"Both men alike were thoroughly methodical in the actual practice of surgery at the bedside or in the operative theatre, but were inclined to be neglectful of their own advantage and well-earned payment for their work. They were men of the self-same temperament, of singular tenacity of purpose and force of will, able to go forward over all kinds of obstacles, and in the end to be successful. Each of them also was emotional, readily moved, either to anger or pity or to generosity."

In the course of an appreciative note to the *British Medical Journal,* Mr. Swinford Edwards, a personal friend and colleague of Mr. Keetley for thirty years, says:

"I should say that Keetley's chief characteristics were his honesty, single mindedness, and generosity. He was a man of great energy, dogged determination, and much resourcefulness in operations. Initiative was another of his strong points, as witness the founding by him of the West London Medical and Chirurgical Society, which is one of the largest and best attended societies in London; the Ladies' Association in connection with the hospital; and the Lincolnshire Society, which I believe largely owes its being to his exertions. The same may also be said of the West London Post-Graduate College, which has proved such a success. He was a recognized authority on orthopædics, and the results of many of his cases of plastic surgery were brilliant. His recent works on appendicostomy and on the preservation of the appendix have attracted much notice. We of the West London shall miss him as a real friend, to whom we could turn for help in

C. B. Keeley

any difficulty, and we shall always remember him in his lighter moments for his very humorous and witty afterdinner speeches, and for his great talent as a pen and ink caricaturist. He was a Fellow of the Medical Society of London and of the Royal Society of Medicine, a corresponding member of the American Orthopædic Society, a member of the Harveian Society, and vice-president of the Balneological and Climatologic Society. He was the author of "An Index of Surgery," which was widely read by students preparing for examination as well as by practitioners, and of which the fourth edition appeared in 1887. He wrote also "The Students' Guide to the Medical Profession," second edition 1885, "Orthopædic Surgery," 1900, and "Complicated Fractures," 1902. He contributed many valuable papers to the medical journals, chiefly upon orthopædic, abdominal, and plastic surgery. He initiated the Army Medical Civilian Reserve, the first unit of which went through a course at the West London Post-Graduate College. His scheme was subsequently merged in the territorial force; Keetley, together with Dr. Fowler, Mr. Godlee, and Sir Thomas Barlow, was appointed a lieutenant-colonel, available on mobilization, in the Third London General Hospital territorial force."

Mr. Rickard Lloyd, in a contribution to the *Lancet,* says:

"Keetley always engaged in his work from a love of the science and a determination to practice it as skilfully and successfully as surgical records showed possible, and to improve upon these records if he could. The courage, thoroughness, ingenuity, and resource which he always displayed were especially shown in the 80's and 90's, when operations were increasing in magnitude and variety almost every day. He was one of the first to adopt Listerian methods, and in his operations he always from the beginning of his hospital career insisted upon thoroughness in antiseptic preparations and precautions. Although so bold a surgeon, he was a very careful one. He allowed as little blood as possible to be lost, and he liked his patients to have the minimum of the anæsthetic administered, preferring ether to chloroform. The results of his operative work were extraordinarily good.

"Keetley's social talents were great, despite his infirmity of deafness. He was exceedingly interesting, original, and generally amusing in his speeches, and a very clever artist. I have seen him illustrate his surgical work scores of times with clever drawings, which he made with amazing rapidity and exactness. I have seen many humorous and caricature drawings that he has made when out of the range of some speaker—and unfortunately deafness, his great misfortune in life, often placed him there."

Mr. Keetley was of good physique and splendid muscular development. The accompanying portrait shows well his personal characteristics. The firm mouth and chin, the finely cut and large nose, and the twinkling eyes suggest the mingling of energy and tenacity and humor which were his essential characteristics. During his student days he was a keen athlete, and was well known as a good foot-ball player, oarsman, and boxer. It is more than probable that at this period he injured his heart, for the existence of the cardiac defect to which he ultimately succumbed was known to him for many years, although his most intimate friends were unaware of it. The last occasion on which the writer had the privilege of seeing Mr. Keetley was in October, 1908. At this time there was no indication that there was any abating of his natural force. An afternoon spent with him at the West London Hospital was full of interest, and the probabilities of a continuance of his surgical activity and great professional usefulness for many years were marked. His response the following year to a request to contribute to the Fest-number, closing the fiftieth volume of the ANNALS OF SURGERY, was cordial and immediate. The news of his sudden death was therefore unexpected, and brought to the writer profound grief.

To Charles B. Keetley,— as a surgeon, skilful, progressive, and bold; as a man wide in his interests, generous, self-sacrificing, and tenacious; as an administrator, broad-minded, sagacious, and planning for the future as well as the present; as a scientist, restless, earnest, and open-minded,—the friend of many years, and a sympathetic and laborious colleague in many labors, the writer now pays this final tribute of affection and respect.

LEWIS S. PILCHER.

# TRANSACTIONS
OF THE
# NEW YORK SURGICAL SOCIETY.

*Stated Meeting, October* 12, 1910.

The President, Dr. Ellsworth Eliot, Jr., in the Chair.

## RESECTION OF RECTUM BY COMBINED METHOD IN TWO STAGES: FIRST STAGE UNDER SPINAL ANÆSTHESIA.

Dr. William C. Lusk read a paper with this title, for which see page 836.

Dr. Howard Lilienthal, after examining the case shown by Dr. Lusk, said the line of union between the mucous edges of the gut was absolutely perfect, and both the patient and Dr. Lusk were to be congratulated upon the result. The case was an excellent example of what could be accomplished in these very difficult cases. It must be recognized, Dr. Lilienthal said, that carcinoma in this region, especially adenocarcinoma, is comparatively non-malignant, so that the patient's chances of recovery were good. The speaker recalled one case of adenocarcinoma of the large intestine at the hepatic flexure which he operated on twelve years ago, and eleven years elapsed before the patient returned with a carcinoma of the rectum, which was of an entirely different type than the original growth. This was also removed, but the patient had since died.

Dr. Lilienthal said he approved of the two-stage operation in cases like the one shown by Dr. Lusk, and he believed that it contributed largely to the patient's recovery.

## TOTAL LARYNGECTOMY FOR EPITHELIOMA: LOCAL ANÆSTHESIA.

Dr. Alfred S. Taylor presented a man, 49 years old, who came to the Fordham Hospital in May, 1910, with the diagnosis of epithelioma of the larynx. The growth had developed to such a size that he was unable to breathe excepting in the upright position, and he also had some difficulty in swallowing. He had lost much weight, and was exceedingly thin and cyanotic.

On account of the location and extent of the growth and the patient's generally unfavorable condition, a general anæsthetic was deemed inadvisable, and it was determined to do a laryngectomy in two stages, first separating the trachea from the larynx, and then, after a week's interval, completing the extirpation of the larynx.

The first stage of the operation was done on May 20, 1910, the following local method of anæsthetizing the parts being employed: With a needle, a 4 per cent. solution of cocaine was injected into the sensory branches of the cervical plexus on both sides of the neck at the middle of the posterior border of the sternomastoid muscles. Dr. Taylor said that prior to attempting this, he had made a large number of dissections on the cadaver, which had convinced him that by injection he could get the cocaine into those nerves either directly or by diffusion. This proved to be the case, as the local anæsthesia was entirely satisfactory.

A sufficiently large incision was then made upward from the episternal notch, through which the upper end of the trachea was dissected out and divided transversely and sutured to the skin with heavy silk sutures. As soon as the trachea was separated from the larynx, a considerable quantity of thick mucus was coughed up, which relieved the patient a good deal.

A week later, under cocaine anæsthesia injected into the sensory branches of the cervical plexus as before, the laryngectomy was completed. The anæsthesia during this operation, as during the primary operation, was very satisfactory, and there was practically no pain excepting when working in the neighborhood of the laryngeal nerves. In addition to the larynx itself, a considerable amount of the mucous membrane posterior to the larynx was removed in order to go wide of the disease. A tube was then inserted through the nostril, and the mucous membranes sutured around it with chromic catgut. The patient got along well for five or six days; then these sutures through the mucous membrane gave way, resulting in a fistulous tract, and the foot of the bed had to be elevated to save the patient from drowning in his own secretions.

In order to catch the very free secretion from the wound, a small pouch was formed over the opening of the trachea by a plastic operation, and through this the patient was able to feed himself through a tube which he passed down into the œsophagus. Just before he left the hospital, he was able to swallow water for the first time with very slight leakage through the fistula. When he returned, about two weeks later, it was found that a stenosis had formed at the pharyngeal scar, so that he was unable to swallow or even introduce the tube into the œsophagus. On August 20, 1910, the patient was etherized through the tracheal tube, and the old scar was dissected out. The upper end of the œsophagus was then separated from the lower end of the pharynx and sutured to the skin, so as to give a free opening for the use of the stomach tube. Since that time the patient had been comfortable and was able to feed himself with the aid of a stomach tube, which he introduced through the opening in the neck.

Dr. John F. Erdmann said the method of anæsthesia employed in the case shown by Dr. Taylor was most interesting and absolutely new to him. The opening made in the œsophagus was also a novel method of procedure. In his own series of cases of complete laryngectomy, numbering perhaps six or seven, a stenosis of the œsophagus and pharynx developed in one instance, necessitating a gastrostomy.

Dr. Ellsworth Eliot said that in some of these cases there was a possibility of carcinomatous deposits in the lower part of the œsophagus, and under those conditions a gastrostomy was preferable to an opening higher up. In one case that came under his observation, an œsophagotomy was done, but on attempting to pass a catheter, an impermeable stricture was found lower down; this proved to be carcinomatous, and a gastrostomy had to be done.

Dr. A. V. Moschcowitz said he had done a number of cases of total extirpation of the larynx under local anæsthesia, although not by the method described by Dr. Taylor. He thought local anæsthesia was preferable to a general anæsthetic on account of the danger of post-operative pneumonia. In one of his cases, the operation lasted over three hours, and another almost three hours; but in spite of this long duration, the patients are better off than after a short operation with general anæsthesia.

Dr. Howard Lilienthal said that in any case of extirpation that he might be called upon to do in the future, he would be inclined to try the intratracheal method of anæsthesia through the tracheal wound. This possessed the advantage of rendering the patient unconscious, and it also avoided the danger of pneumonia, at least to a much greater extent than by the ordinary inhalation method, as by the intratracheal method any secretions would be blown out. Unless it could be demonstrated that the œsophagus was permeable, Dr. Lilienthal said he would regard a gastrostomy safer than an opening higher up.

Dr. Taylor, in closing, said that in his case there was no obstruction of the lower œsophagus whatever, and the tube could be passed without any trouble.

Dr. Taylor said that by injecting the cocaine into the sensory branches of the cervical plexus as he had described, the entire anterior aspect of the neck was anæsthetized. These nerves supply the sensory branches to this region. One decided advantage of this method over the local injection of cocaine was that it did not give rise to an œdematous condition of the tissues upon which it was necessary to operate. Very little cocaine was necessary, and the anæsthesia it gave rise to was entirely satisfactory. The method was described about a year ago by one of the men connected with the Johns Hopkins Hospital.

## RUPTURE OF THE LIVER FOLLOWED BY SUBPHRENIC ABSCESS.

Dr. Burton J. Lee presented a boy of thirteen from the service of Dr. John Rogers at Bellevue Hospital, who gave the following history: About half-past two in the afternoon, while watching a ball game, he was struck on the right side of the thorax, low down, by a bat, which had slipped from the batter's hands as he was attempting to hit the ball. The distance between the latter and the lad was about ten feet. The patient suffered severe and sudden pain in the region named, was almost breathless for an instant, and then felt somewhat better, though he remained weak and soon complained of thirst. He walked about three blocks to the hospital.

When the patient was examined by Dr. Stilson, the house surgeon, about an hour and a half after the accident, he showed considerable shock, and was very pale, weak, and thirsty. There were slight rigidity and some tenderness in the upper right quadrant of the abdomen, but no dulness in either flank, the latter symptom appearing about two hours later. At that time, the rigidity over the upper part of the right rectus was more marked, and tenderness in the same region had increased. A blood examination made about this time showed hæmoglobin, 100 per cent.; red blood cells, 4,896,000; white cells, 30,000, and polymorphonuclears 89 per cent.

An operation was decided upon, and on opening the abdomen through a vertical incision over the upper part of the right rectus, there was a gush of blood, which was controlled by pressing the liver directly against the diaphragm. The superior surface of the liver was then examined, and a Y-shaped rupture about three inches long was found close to the attachment to the diaphragm, the left arm of the Y extending almost to the median line.

As it was impossible to reach the tear in the liver by either cautery or suture, the hemorrhage was controlled by tightly packing gauze into the rent. A large piece of packing was placed below the liver, with the object of forcing that organ up against the diaphragm. The wound was closed in layers, and a large piece of gauze was tightly strapped against the liver over the wound to further push the liver upward.

Two days after the operation the boy's hæmoglobin registered 75 per cent., with 3,432,000 red cells. On the tenth day the blood analysis gave practically the same results, with 16,000 white cells and 80 per cent. of polymorphonuclears. Transfusion by the Elsberg canula was attempted two days after the operation, but was unsuccessful.

Nine days after the operation the gauze drains in the tear in the liver were completely removed, and no oozing followed. Subsequent to this, there was persistent tenderness over the upper abdomen, with accompanying temperature elevation. Two weeks after the original operation, an exploratory operation was done by Dr. Erdmann over the upper left abdomen, but the findings were negative. A week later the right chest gave signs of dulness posteriorly, low down. Three explorations with the needle were made, with negative results. Six weeks after the operation the right chest was opened by Dr. Lee with negative findings. Two days later, Dr. John A. Hartwell, the attending surgeon, obtained pus by needle exploration on the left side below the diaphragm, and later a large cavity was opened and drained.

This cavity, apparently, did not communicate with the right side of the abdomen. From this time the boy went on to complete recovery. He ran a temperature continuously for seven weeks following the original injury. Five weeks after the first operation, his hæmoglobin had dropped to 20 per cent. His abdominal wound on the left side had now entirely healed, and that on the right side over the original site was but a minute sinus about half an inch long. His general condition was excellent.

The interesting features of this case, Dr. Lee said, were: 1. The site of the rupture in the liver, making the use of suture or cautery impossible. 2. The efficiency of packing in controlling hemorrhage from the liver. 3. The long and complicated course of the case, with the final disclosure of the left-sided subphrenic abscess.

## THE ANATOMY AND TREATMENT OF UNDESCENDED TESTIS; WITH ESPECIAL REFERENCE TO THE BEVAN OPERATION.

Dr. A. V. Moschcowitz read a paper with the above title, for which see page 821.

In connection with his paper, Dr. Moschcowitz presented a number of patients showing the result of the method of operation described by him.

Dr. Robert T. Morris thought that in the treatment of undescended testis we had little need for any other operation than that devised by Bevan. A few days after the original description of that operation was published, he employed the method on a case and had found that he could lengthen the vas from two to three inches, and since then he had not found it necessary to resort to any other method. By cutting everything excepting the vas and its artery, the vas immediately unravels for three or four inches without any trouble, as a rule, in adults.

Dr. Morris said he was not altogether sure that it was even necessary to spare the artery of the vas, which followed usually very close to the vas and was quite as tortuous as the vas itself, but he recalled two or three cases where there was an anomalous distribution of the artery and where he was not at all sure that the artery was saved, and yet those cases resulted favorably, the lymphatic circulation apparently maintaining the organ until a new blood supply was established.

Dr. Morris said that should the testicle slough, or in cases where the undescended testis was so small that it was scarcely worth while to bring it down, he would remind the members of the Society of Dr. Robert F. Weir's suggestion regarding the psychical and æsthetic value of a celluloid substitute. The speaker said he had resorted to this procedure in a number of instances, chiefly after the removal of the testis for tuberculosis or as the result of injury. The celluloid substitute for the testis should be immersed in a physiological salt solution just before insertion and after sterilizing it in a 5 per cent. formalin solution. These celluloid substitutes are made to order by the celluloid company in New York after Dr. Weir's models.

Dr. Howard Lilienthal suggested that perhaps the sterilization of the celluloid testis might be dispensed with, as it was already sterile.

Dr. John B. Walker said that in 125 cases of undescended testis upon which he had operated, he did not think that he had employed the Bevan method more than two or three times. He had not found it necessary to divide the vessels. The chief difficulty he had encountered was in the division of the connective tissue.

Dr. Walker said he agreed with Dr. Moschcowitz that the vas was always sufficiently long. He had found that in very young children, when the testis was brought down, the cord gradually lengthened as time went on. In separating the sac from the vas, it was essential to use the greatest care to avoid injuring the parts. As the majority of these operations was done on comparatively young children, generally during the third or fourth year, when the vas was very small, he thought it important that all the vessels should not be divided.

Dr. Howard Lilienthal said he had operated on a number of cases by the Bevan method, and for the most part successfully, but in one instance he was compelled to remove the testis on account of sloughing. That patient was a boy about eight years old, and the operation was very easily performed; the testicle was held in its new position without undue tension, and yet necrosis set in.

Dr. William A. Downes said he had done the Bevan operation as described by Dr. Moschcowitz about twenty times with entire success. In all of his cases it was easy to divide the sac at the internal ring, and there was no difficulty in saving a sufficient amount of the lower end of sac to form a tunica vaginalis—a step which Dr. Bevan considers very important. Dr. Downes understood from Dr. Bevan that while the dividing of the spermatic artery and veins might be necessary in an exceptional case, that it was not the essential feature of his operation.

Dr. Downes said he had never seen sloughing of the testis in any of his cases. The scrotum usually became ecchymotic, but the swelling disappeared in a few days, and within a few weeks the testis appeared to be in a normal condition. As to the age at which the operation should preferably be done, the speaker said he preferred to operate between the ages of eight and fourteen years rather than earlier.

Dr. Moschcowitz, in closing, said he would not care to operate on these cases earlier than the age of three years; he had operated on children as young as that, and many of the people who brought their children to the hospital were anxious to have the operation done as early as possible. The age at which the operation should preferably be done depended somewhat on the class of patients we had to deal with.

The speaker said that this condition of undescended testis was always complicated by hernia, which could not be taken care of efficiently by any form of truss. In view of the fact that we did not oppose a radical operation for the cure of hernia in a child of three years, he saw no reason why the other condition should not be corrected at the same age. From that time on the operation could be done up to almost any age.

Dr. Moschcowitz said that Dr. Bevan's original article was published in the *Journal of the American Medical Association,* and his more extensive paper in Langenbeck's Archives. He had studied the paper very carefully, and thought he understood its purport, as well as its advantages over the Schüller and other operations; if Dr. Bevan did not claim the points he had mentioned as the particular advantages of his method, then he was sorry for it, because he regarded them as of paramount importance.

# BOOK REVIEWS.

Epoch-making Contributions to Medicine and Surgery and the Allied Sciences. Collected by C. N. B. Camac, A.B., M.D. With portraits. Philadelphia, W. B. Saunders Company, 1909.

The title-page of this book states that it contains reprints of those communications which conveyed epoch-making observations to the scientific world, together with biographical sketches of the observers. Upon opening its pages we find that under this head the author has included Joseph Lister and his paper on "The Antiseptic Principle of the Practice of Surgery," read at the meeting of the British Medical Association, August 9, 1867; William Harvey and his booklet on "The Motion of the Heart and Blood in Animals," 1628, Willis' translation; Auenbrugger and a translation of his original treaties on "Percussion of the Chest," 1761; Laennec and his treatise on "Diseases of the Chest and Mediate Auscultation," 1818; Jenner and his tracts on "Variolae Vaccinae," 1798 to 1800; Morton, and his remarks on "The Proper Mode of Administering Sulphuric Ether by Inhalation," 1847; Oliver Wendell Holmes, and his paper on "The Contagiousness of Puerperal Fever," 1843. Biographical sketches and lists of the writings of the various authors quoted accompany these papers. Dr. Camac says in his introduction that he has made no effort to present his subjects in chronological order, but his main idea has been to select these epoch-making articles—which he regards as masterpieces of scientific research—from the great mass of valueless or ephemeral writings among which the student must search for them if he desires to find them. The best English translation has been selected for articles which appeared in a foreign tongue. Dr. Camac has done an altogether admirable thing in bringing together these papers and putting them in shape that makes them at once accessible to every one. Naturally, those contributions which present the work of the Anglo-Saxon race have taken first place in the estimation of the compiler, and one realizes in glancing over the list how large a part in bringing to the use of mankind resources in the healing art of the greatest magnitude the workers of that race have been permitted to play. Lister, Harvey, Jenner, Morton—Antisepsis, The Motion of the Heart and Blood, The Prevention of Smallpox, and the Abolition of Pain during Surgical Procedures—no similar list, in the far-reaching extent of the benefits that these have conferred, can be compiled.

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Here is a specimen paragraph, reprinted in this space not so much to show the scope and character of the offering as to emphasize its helpful tone and to point out the fact that its author was not actuated wholly by motives of commercialism:

"Medical practitioners have learned that, inasmuch as the main problem presented in the treatment of a case of diphtheria is the neutralization of a specific toxin, the true antitoxin cannot too soon be administered; moreover, that, antitoxin being a product of definite strength, a little too little of it may fail when a little more would have succeeded—hence larger or more frequently repeated doses are becoming more and more the rule. One more point: if the medical attendant is prompt, as he must be, and fearless, as he has a right to be, the full justification of his course will hinge upon the choice of the best and most reliable antidiphtheric serum to be had; for while there is little or no danger of harm ensuing from the use of any brand issued by a reputable house, the best results—which may mean recovery as the alternative of death—can only be hoped for from the use of the best serum."

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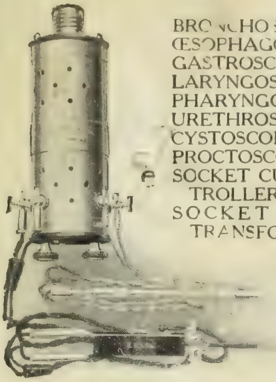

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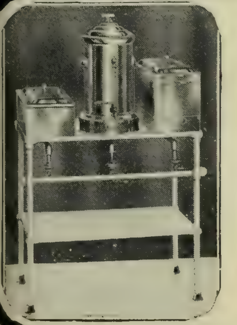

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In the treatment of recurrent dysmenorrhea, the most gratifying results are obtained by beginning the administration of Ergoapiol (Smith) three or four days in advance of the menses, and continuing its employment until menstruation has ceased.

Despite the fact that Ergoapiol (Smith) exerts a pronounced analgesic and sedative effect upon the entire reproductive system, it is not attended with the objectionable effects associated with anodyne or narcotic drugs.

The invariable certainty, agreeableness, and singular promptness with which Ergoapiol (Smith) relieves the several varieties of dysmenorrhea has earned for it the unqualified endorsement of those members of the profession who have subjected it to exacting clinical tests.

While hot sitz-baths, vaginal injections, and similar measures may be advantageously employed in conjunction with Ergoapiol (Smith), their use is not essential; in fact, the preparation will invariably prove sufficient to relieve the pain attending menstruation.

The impressive analgesic and tonic action of Ergoapiol (Smith) upon the uterus and its appendages render it of conspicuous service in the treatment of all anomalies of the catamenia associated with pain.

### THE OLD LOVE

*Cigar*: "Why do you look so lovingly at that old match on the floor?"

*Cigarette*: "It was an old flame of mine."

—*October Lippincott's.*

### MOIST HEAT

Thermotherapy in inflammatory conditions seems to prove most effective when applied in the form of moist heat.

The relaxation of pressure by infiltrated and swollen tissues upon nerve endings, as experienced by the relief of pain, specifically proves this.

The advantages of moist heat where indicated is generally acknowledged. The method of its application from professional preferment seems to be in the form of Antiphlogistine. By this method, a high temperature can be maintained in contact with the affected part for hours without exposure to the patient for redressing.

The superior advantages of Antiphlogistine over other forms of moist dressings, such as poultices, hot packs, etc., are that it is easily applied, retains its heat for hours, is antiseptic in action, and above all produces satisfactory therapeutic results.

### FEEDING TYPHOID PATIENTS

In prescribing a sole milk diet for typhoid fever many overlook the fact that milk alone on entering the stomach becomes almost solid, and large, firm curds are likely to prove irritating to the ulcerating surfaces. When patients are fond of milk and seem to digest and absorb it thoroughly, there is no better diet when employed with Bovinine. It answers every requirement of a perfect fever food. Those who dislike milk or do not seem to digest it do well on Bovinine in barley, rice, or plain, and later, when the digestive condition has improved, milk may again be taken up.

### WHY THE BOY GAVE THANKS

Alan had played the entire day with Little Brother without an impatient word. After saying his customary prayer that night, his mother suggested that he add: "I thank God I was not impatient with Little Brother today." This he did with much fervency; after which he remarked that there were some other things he would like to thank God for, and forthwith he closed his eyes and said:

"I thank God I offered my candy to Father before taking any myself.

"I thank God I offered my candy to Mother before taking any myself.

"I thank God I offered my candy to Little Brother before taking any myself.

"And I thank God there was some left."

—*October Lippincott's.*

**LISTERINE**

toxi

is a saturated solution of bor
forced by the antiseptic properties
erous oils. It is unirritating, even
applied to the most delicate tissue. It d
not coagulate serous albumen. It is particularly useful in the treatment of abnormal conditions of the mucosa, and admirably suited for a wash, gargle or douche in catarrhal conditions of the nose and throat.

There is no possibility of poisonous effect through the absorption of Listerine.

**Listerine Dermatic Soap** is a bland, unirritating and remarkably efficient soap.

The important function which the skin performs in the maintenance of the personal health may easily be impaired by the use of an impure soap, or by one containing insoluble matter which tends to close the pores of the skin, and thus defeats the object of the emunctories; indeed, skin diseases may be induced, and existing disease greatly aggravated by the use of an impure or irritating soap. When it is to be used in cleansing a cutaneous surface affected by disease, it is doubly important that a pure soap be selected, hence Listerine Dermatic Soap will prove an effective adjuvant in the general treatment prescribed for the relief of various cutaneous diseases.

*"The Inhibitory Action of Listerine," a 128-page pamphlet descriptive of the antiseptic, and indicating its utility in medical, surgical and dental practice, may be had upon application to the manufacturers, Lambert Pharmacal Co., St. Louis, Missouri, but the best advertisement of Listerine is- - - - - - - - - - - - -* **LISTERINE**

## NTITOXIN

the physi-
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iate all
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detail? This
thought is [illegible] on the writer through the perus[illegible] ht publication of Parke, Davis & Co., which deals in part with the subject of antitoxin manufacture.

Here is a specimen chapter:

"In the selection of the horses which are to [illegible] as the living laboratories for the production of the antitoxin, we apply not commercial or academic knowledge merely, but, what is more to the point, veterinary skill. The animals must be vigorous and healthy. They are carefully examined, their temperature noted for several days, and the presence of glanders excluded by the delicate mallein test. It is the blood-serum of these animals that is to be injected into the patient later on, and no precaution can be regarded as extreme which contributes the slightest positive assurance of its purity.

"Not only must the horses be in good general condition when inoculated; they must be kept so. They are fed, stalled, groomed, and exercised for no other purpose than to maintain to the full their self-protective, antitoxin-producing powers. Thirty iles removed from the noise, smoke, and ust of the city is our stock farm, equipped th model stables and supervised by expert erinarians. Here, at Parkedale, on more han three hundred acres of sunny slopes, at n altitude of six hundred feet above the evel of the Great Lakes, live the horses which we employ in serum-production. Amid these favorable surroundings they maintain the physical condition so essential to satisfactory service as serum-producers.

"These are preliminary considerations. Young, healthy, well-kept horses, indispensable as they are, would be of little use in [illegible] boration of a reliable antitoxin unless [illegible] ork of injecting them with toxin were conducted accurately, aseptically, systematically, [illegible] throughout a period long enough to [illegible] physiological reaction up to the limit of attainable immunization. We have horses enough, so that there is no occasion to be in a hurry with any of them; the exact length of time required for complete reaction is determined in each individual instance by carefully scheduled observations.

"It goes without saying that in the preparation of the toxin and its injection into the horses, as well as in obtaining the blood serum, the most rigid bacteriological technique is maintained. The methods we employ agree substantially with those of Roux, Aronson, and Behring, and are from first to last in charge of experts. The varying susceptibility of different animals, whether guinea-pigs or horses, to the diphtheria p[illegible] the more or less rapid physiological
[illegible] the variation in strength of the
serum from different horses; the
urity of the finished product—
[illegible] important and delicate questions de[illegible]ing for their determination a high degree of skill and scientific accuracy of observation. These qualifications, in our judgment, outrank all other considerations in the work of producing a reliable antidiphtheric serum."

The foregoing has reference to but a single step in the process of serum production, and affords but a hint of the safeguards with which Antidiphtheric Serum (P. D. & Co.) is hedged about at every stage of its manufacture—conditions which enable the company to guarantee the purity and potency of its antitoxin.

## GERMICIDAL POWER OF LYSOL

The germicidal power of Lysol is as follows:

Staphylococcus Pyogenes Aureus: Growth diminishes after two minutes' exposure in a solution of 0.25 per cent.; growth destroyed or arrested after fifteen minutes' exposure in a solution of 0.30 per cent.; growth destroyed after five minutes' exposure in a 1-per-cent. solution.

Streptococcus: Growth destroyed or arrested after fifteen minutes' exposure in half-per-cent. solution.

Laboratory tests for demonstrating germicidal power and use in clinical work involve very different conditions. In laboratory tests the actual destruction of the bacteria by the solution unaided is necessary. In clinical work the process involves both destruction and removal of these growths. Therefore an agent, to be effective, must possess the power not only of destroying but of loosening and removing the bacteria from the surface or structure to which they adhere. Lysol possesses this particular power.

## BED-PANS AND BED-SORES

As is well known, bed-sores are caused by continual pressure on the parts, and are aggravated by contact with urine and feces.

It seems a long call from bed-sores to bed-pans, but how many of your readers have noticed that the use of certain bed-pans will do much to either relieve, or increase, the suffering of a bed-sore patient?

In several cases recently it was noticed that bed-sore patients are frequently compelled to use the old-fashioned French bed-pan, or Hank's Douche Pan, whereas by the use of the Meinecke "Perfection" Bed-Pan they would have been saved much pain, as the shape which conforms to the body of the patients prevents undue pressure on the sores, as is the case with the bed-pans mentioned above.

# HYDROLEINE

**An emulsion of cod-liver oil after a modification of the formula and process devised by H. C. Bartlett, Ph. D., F. C. S., and G. Overend Drewry, M. D., M. R. C. S., London, England.**

## Distinctively Palatable Exceptionally Digestible

### Ethical Stable

Hydroleine is simply pure, fresh, cod-liver oil thoroughly emulsified, and rendered exceptionally digestible and palatable. Its freedom from medicinal admixtures admits of its use in *all* cases in which cod-liver oil is indicated. The average adult dose is two teaspoonfuls. Sold by druggists. Sample with literature will be sent *gratis* on request.

THE CHARLES N. CRITTENTON CO.
115 FULTON ST., NEW YORK

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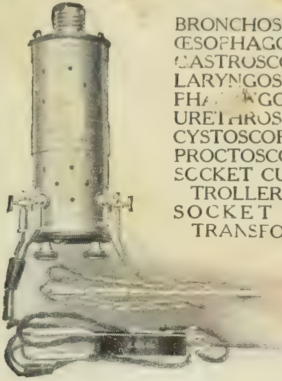
# Elec
## Surgica

The Sixth Ed or o
which will be mailed on
large line of instruments, inclu



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SOCKET CAUTERY TRANSFORMERS, ETC.

Socket Cautery Transformer.

ORIGINATION BEGETS IMITATION
BE SURE OF OUR EXACT NAME

## Electro Surgical Instrument Co.
ROCHESTER, N. Y.

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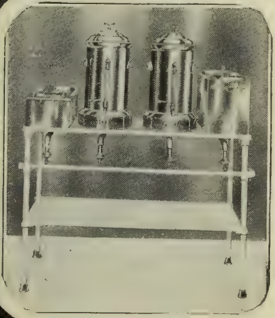

## THE CASTLE
# Rochester Sterilizing Outfits

combine in one apparatus, instrument, dressing, and water sterilizers. They are made as Two-Piece, Three-Piece, and Four-Piece Outfits. Each Outfit is made in a large size for Hospitals and in a smaller one for Physicians' offices. Can be adapted to any heating arrangement.

**The illustration shows the Four-Piece Outfit.**

Ask your dealer for descriptive circulars, or address

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**607 St. Paul Street Rochester, N. Y.**

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**THE POTTENGER SANATORIUM** — For Diseases of the Lungs and Throat — **MONROVIA CAL.**

A thoroughly equipped institution for the scientific treatment of tuberculosis. High-class accommodations. Ideal all-year-round climate. Surrounded by orange groves and beautiful mountain scenery. Forty-five minutes from Los Angeles.

F. M. POTTENGER, A.M., M.D., LL.D., Med. Director J. E. POTTENGER, A.B., M.D., Ass't Med. Director and Chief of Laboratory

For particulars address **Pottenger Sanatorium, Monrovia, California**
Los Angeles Office, 1202-3 Union Trust Bldg., Cor. Fourth and Spring Streets.

## [illegible]EPSIS OF THE INTESTINAL CANAL

The griping pain and flatulence which accompany bowel and stomach complaints, particularly during the heated term, are so readily overcome and controlled by the timely administration of one or two Antikamnia and Salol Tablets, repeated every two or three hours, that it behooves us to call our readers' attention to the grand efficacy of this well-known remedy in these conditions. The above doses are, of course, those for adults.

Children should be given one-fourth tablet for each five years of their age. When the attack is very severe, or when the disturbance is evidenced at or near the time of the menstrual period, we find it preferable to give two Antikamnia and Codeine Tablets, alternately with the Antikamnia and Salol Tablets. The latter tablets promptly arrest excessive fermentation and have a pronounced sedative effect on the mucous membrane of the bow[illegible]l stomach, and will check the various [illegible]œas without any untoward effect.

## COUGH

Among the late remedies for this class of [illegible] heroin, and it certainly has proved a valuable addition to our *materia medica*. [illegible] are many combinations in use, of [illegible] heroin is the chief constituent. Some, [illegible] opinion, are not to be recommended [illegible] general use. What is needed is a safe [illegible] efficient preparation whose action is [illegible]e and definite. Such a combination [illegible]e in Glyco-Heroin (Smith), made by [illegible] H. Smith Co., of New York. Each [illegible]n of this mixture contains heroin, gr. [illegible] ammonia hypophos., hyoscyamus, [illegible] pine bark, balsam tolu, glycerin, ad [illegible] the astringent properties of white pine [illegible]e of peculiar service in inflammations of the respiratory tract. It also is of use in arresting the night sweats of phthisis. Balsam of tolu is an aromatic, useful in chronic bronchitis or in the advanced stage of the acute disease. Altogether the mixture has, in my hands, proved to be of the greatest value, and at least a dozen of my medical friends to whom I have recommended it are loud in its praise.—Francis W. Campbell, M.A., M.D., D.C.L., L.R.C.P., London.

Retribution is what we think will happen to the man who does n't think as we think he should think.

—*November Lippincott's.*

## BENGER'S FOOD

Among the prominent passengers who landed from the "Baltic" recently was W. [illegible] Conyngham, Ph.C., F.C.S., who [illegible]s here in the interest of Benger's Food, Ltd., Manchester, England.

Benger's Food for twenty-five years has held the approval and confidence of the medical profession in England. Although the Food has already gained the support of many of the leaders among the profession here, the manufacturers propose to make it equally well known to doctors in every section of this country.

Mr. Conyngham is eminently equipped to accomplish this service, both by training and experience. His father was the managing director of the well-known firm of Irish chemists, Hayes, Conyngham & Robinson, Ltd., of Dublin, and he himself was for some time one of the English representatives of the firm of Parke, Davis & Co. Mr. Conyngham will cooperate with Lamont, Corliss & Co., the selling agents for Benger's Food in the United States, in an increasingly active campaign. We wish them every success.

## THE COLD-STORAGE WAIL

"Say, Boss, I worked off some of that cold-storage butter to-day," said the new clerk, with an air of one who expected a compliment.

"Indeed! Well, that's good! Who drew the prize?" said the pleased grocer; for it was getting to be a difficult thing to do.

"Why, I sent it to Mrs. Hash around on Board Street."

"Oh, thundering guns!" exclaimed the grocer, his tone changed and his face drawn in a pucker. "Why, you blamed idiot, I board at that woman's house!"

—*November Lippincott's.*

## A LIVELY CAMPAIGN

In a small New Jersey town the local political campaign was being fought to a bitter end, and both factions claimed the election as their own. One of the political leaders met a prominent merchant of the town, and they began to discuss the situation.

"How is the campaign coming along down in your ward?" asked the merchant.

"Very exciting," said the politician. "Next week we are going to have a joint debate in the town hall between a phonograph and a graphophone."

—*November Lippincott's.*

**LISTERINE** is a powerful, non-toxic antiseptic. It is a saturated solution of boric acid, reinforced by the antiseptic properties of ozoniferous oils. It is unirritating, even when applied to the most delicate tissue. It does not coagulate serous albumen. It is particularly useful in the treatment of abnormal conditions of the mucosa, and admirably suited for a wash, gargle or douche in catarrhal conditions of the nose and throat.

There is no possibility of poisonous effect through the absorption of Listerine.

**Listerine Dermatic Soap** is a bland, unirritating and remarkably efficient soap.

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## ELECTRO SURGICAL INSTRUMENT COMPANY

It is now fourteen months since the Electro Surgical Instrument Company, of Rochester, N. Y., were visited by a disastrous fire which completely destroyed their factory. They were soon, however, able to establish themselves in a modern fire-proof building, and with new machinery and increased facilities are now turning out even better instruments than before. The fact that they were able promptly to resume manufacturing under such favorable conditions is cause for congratulation both for themselves and their patrons, inasmuch as the history of the use of the miniature electric light in diagnosis and treatment is closely interwoven with that of this company. They made the first electrically lighted urethroscope, the Koch, and they have just completed the latest, an operating and dilating urethroscopic set designed by Dr. Hugh H. Young of Baltimore. They made the first practicable cystoscope designed in this country and they have made the two latest, the E. S. I. Co. Combination and that of Dr. W. F. Braasch of Rochester, Minn. They were the pioneers in this line, and years of experience and the suggestions of many eminent physicians both at home and abroad have enabled them to bring their instruments to a state of perfection which renders them models of their kind; and as now made by this company, properly designed and skillfully constructed, these have become indispensable for that accuracy of diagnosis and treatment which modern medicine demands. The vital part of such instruments is the small electric lamp, and to every part of the manufacture of these especial care is devoted. All are of the "cold" variety, i.e. their temperature is but slightly above that of the body, they give a brilliant white light and have great endurance. The Electro Surgical Instrument Company make all kinds of electrically lighted instruments, such as cystoscopes, urethroscopes, Jackson bronchoscopes, auriscopes, an illuminated eye spud, transilluminators, etc. They manufacture, also, all kinds of current-controlling devices, including a socket current controlier, a socket cautery transformer, and wall plates—and everything they make they make well.

## THE HAPPY MAN

"I hear she is to be married. Who is the happy man?"

"Her father."

—*December Lippincott's.*

## A VALUABLE AND SEASONABLE REMEDY

To reduce fever, quiet pain, and at the same time administer a laxative and tonic is to accomplish a great deal with a single tablet, and we would especially call attention to the wide use of Laxative Antikamnia and Quinine Tablets in chronic or semi-chronic diseases which begin with a severe "cold." Among the many diseases and infections which call for such a combination, we might mention la grippe, influenza, coryza, coughs and colds, chills and fever, and malaria with its general discomfort and great debility. Attention is particularly called to the therapeutics of this tablet. One of its ingredients acts especially by increasing intestinal secretion, another by increasing the flow of bile, another by stimulating peristaltic action, and still another by its special power to unload the colon. When the temperature of the body is above normal, conditions are especially favorable for germ development. It is a matter of every-day observation that a simple laxative is often sufficient to relieve the most serious complications.—*Archives of Pediatrics.*

## MIXED EMOTIONS

A Bostonian tells of a clean, well-set-up young Irishman, who formerly saw service in the British navy, but who is now engaged in business at the Hub.

"When are you going to get home rule in Ireland, John?" the Bostonian once idly asked.

"The only way that we'll get home rule in ould Ireland," said the Celt, "will be if France—an' Russia—an' Germany—an' Austria—an' maybe Italy—if they would all join together to give those blackguards of England a rare ould batin'. That's the only way, sir, we'll get home rule."

Then, as he looked cautiously round, a twinkle of cunning was added to his expression. "An' the whole lot of 'em together couldn't do it, sir. Oh, it's the grand navy we've got!"—*December Lippincott's.*

## CREDIT WHERE CREDIT IS DUE

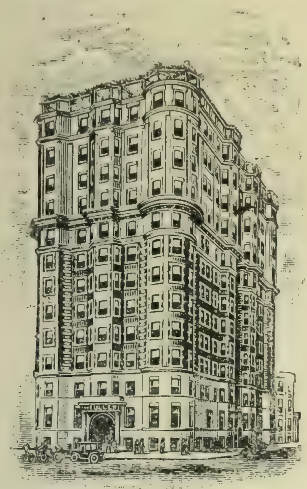
"I don't think much of Fletcher,"
Remarked the mooley cow.
"I know he claims the credit,
But 't was I who showed him how!"

—*December Lippincott's.*

WHEN IN DETROIT STOP AT

## HOTEL TULLER

New and Absolutely Fireproof
**Corner Adams and Park Streets**



In the center of the Theatre, Shopping, and Business District.
Has Large Convention Hall, "Grand Roof Garden Cafe."
Music from 6 p.m. to 12 p.m.

Every Room Has Private Bath.

EUROPEAN PLAN—RATES, $1.50 per day and up.

**L. W. TULLER, Prop.**

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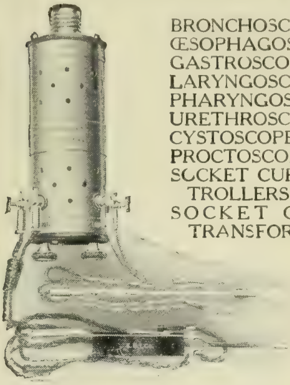
## Electrically-Lighted Surgical Instruments

The Sixth Edition of our illustrated catalogue, which will be mailed on request, describes our large line of instruments, including

- BRONCHOSCOPES
- ŒSOPHAGOSCOPES
- GASTROSCOPES
- LARYNGOSCOPES
- PHARYNGOSCOPES
- URETHROSCOPES
- CYSTOSCOPES
- PROCTOSCOPES
- SOCKET CURRENT CONTROLLERS
- SOCKET CAUTERY TRANSFORMERS, ETC.



Socket Cautery Transformer.

ORIGINATION BEGETS IMITATION
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**Electro Surgical Instrument Co.**
ROCHESTER, N. Y.

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THE CASTLE

## Rochester Sterilizing Outfits

In the Dressing Sterilizer dressings are first heated in dry air; then steam is admitted at the top at one end and passes out at the bottom at the opposite end; the dressings being finally dried by hot air. One valve controls all operations.

The illustration shows the Two-Piece Outfit.

For circulars illustrating the Castle line of sterilizers, ask your dealer or address

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607 St. Paul St. Rochester, N. Y.

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**THE POTTENGER SANATORIUM** — For Diseases of the Lungs and Throat — **MONROVIA CAL.**

A thoroughly equipped institution for the scientific treatment of tuberculosis. High-class accommodations. Ideal all-year-round climate. Surrounded by orange groves and beautiful mountain scenery. Forty-five minutes from Los Angeles.

F. M. POTTENGER, A.M., M.D., LL.D., Med. Director J. E. POTTENGER, A.B., M.D., Ass't Med. Director and Chief of Laboratory

For particulars address **Pottenger Sanatorium, Monrovia, California**
Los Angeles Office, 1202-3 Union Trust Bldg., Cor. Fourth and Spring Streets.

## THE HEATH MATERNITY CORSET

The Heath Maternity Corset is made with a long, graceful front which entirely covers up and supports the abdomen. The upper part is full and roomy so as to support without giving any harmful pressure.

The entire front of the corset is soft, being fastened with glove-buttons instead of steel clasps. The little boning is watch-spring Walohn, very pliable and light, with just enough stiffness to hold the garment in shape. The double row of lacing in front permits adjustment and enlargement of the entire corset, thus furnishing a perfectly fitting garment throughout the entire period.

The construction in back is equally important, as it furnishes the support that is required to relieve the "backache" so frequent during pregnancy.

The double adjustable elastic straps in back, a unique feature of all Heath Corsets, accommodate themselves freely to every movement. Whether standing, sitting, walking, or riding, this corset gives perfect support and freedom of movement.

Pomeroy Company, of 34 East 23rd Street, New York, says it is a pleasure to recommend and sell the Heath Maternity Corset on account of the expressions of approval given by every customer immediately after trying one on.

The Heath Maternity Corset merits this approval because it is the only maternity garment which combines the features of comfort and beneficial support, together with a decided improvement in the personal appearance of the wearer.

## GLYCO-HEROIN (SMITH)

It is self-evident that a preparation which embraces the fore-mentioned drugs in proper proportions must needs possess cough-alleviating, inflammation-subduing, and repair-inducing properties in the highest possible degree. That such a preparation is capable of effecting improvement of such ailments as coughs, pneumonia, bronchitis, and laryngitis, there can be no question.

By utilizing, collectively, the analgesic, sedative, calming, and febrifuge properties of heroin; the spasm-alleviating, inflammation-subduing, respiration-tranquillizing, and anxiety-dispelling properties of henbane; the heart-stimulating, mucous-modifying, secretion-expelling, and fever-reducing properties of ammonia hypophosphite; the soothing, antiseptic, and sedative properties of balsam tolu; and the astringent, stimulating, and balsamic properties of white pine bark we obtain a remedy which, in point of remedial value and extent of usefulness, has no superior.

In addition to promptly relieving the pain, abating the fever, augmenting the expulsion of accumulated secretion, allaying nervous excitement, overcoming alarm, subduing inflammation, and diminishing cough, Glyco-Heroin (Smith) brings about a condition favoring uninterrupted and very rapid recovery.

When used at the first sign of developing disorder, Glyco-Heroin (Smith) shortens the duration of the ailment; given when the disorder has already established itself, it alters the degree of discomfort, modifies the severity of the attack, and tends to preclude the development of perilous complications.

## VERY CONSOLING

Mr. Brown had gone up to the attic and hanged himself. While the sorrow of the widow was keenest, her neighbor, Mrs. Jones, came to comfort her. Mrs. Jones, because of her reputation for always saying the wrong thing, had secured the consent of her own family to make the visit only on her promise that she would talk about subjects foreign to the cause of her friend's grief. She commenced on safe ground by talking about the weather.

"Rather nice weather we've been having, Mrs. Brown."

"Yes," said Mrs. Brown; "but it has been too wet to get our washing dry."

"Oh, well, you needn't worry about that, Mrs. Brown, as you have such a nice attic to hang things in."

*December Lippincott's.*

## ALL READY FOR THE SHOW

*Orchestra Leader:* "All the orchestra players are drunk."

*Theatrical Manager:* "Well, drag 'em out. We advertised a full orchestra."

*December Lippincott's.*

## HIS PUNISHMENT

"What makes you so late?"

"I had words with the teacher."

"Indeed?"

"Yes; I couldn't spell them."

*December Lippincott's.*

A set of sables in good time is a fairly effective preventive of a rapidly cooling love.

*December Lippincott's.*

Vol. LII DECEMBER, 1910 No. 6

# ANNALS OF SURGERY

A Monthly Review of Surgical Science and Practice.

Edited by LEWIS STEPHEN PILCHER, M.D., LL.D., of New York.
WITH THE COLLABORATION OF
J. WILLIAM WHITE, M.D., LL.D., OF PHILADELPHIA.
SIR WILLIAM MACEWEN, M.D., LL.D., OF GLASGOW.
SIR W. WATSON CHEYNE, C.B., F.R.S., OF LONDON.

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### BOOK REVIEW

*Camac:* Epoch-making Contributions to Medicine and Surgery and the Allied Sciences... 864

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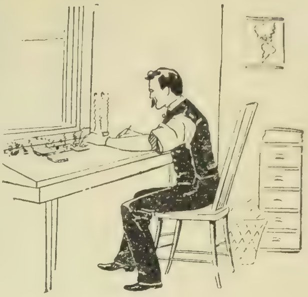

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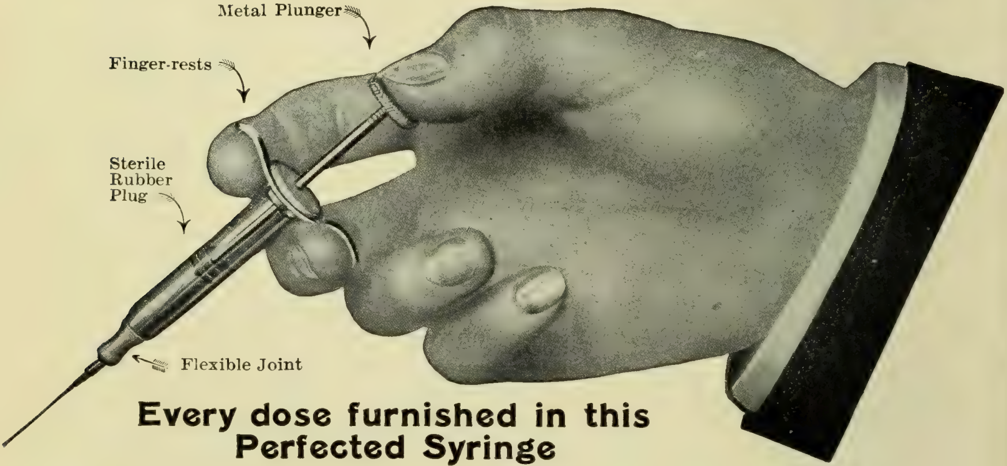

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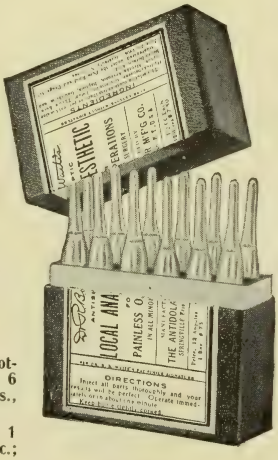

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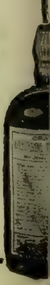

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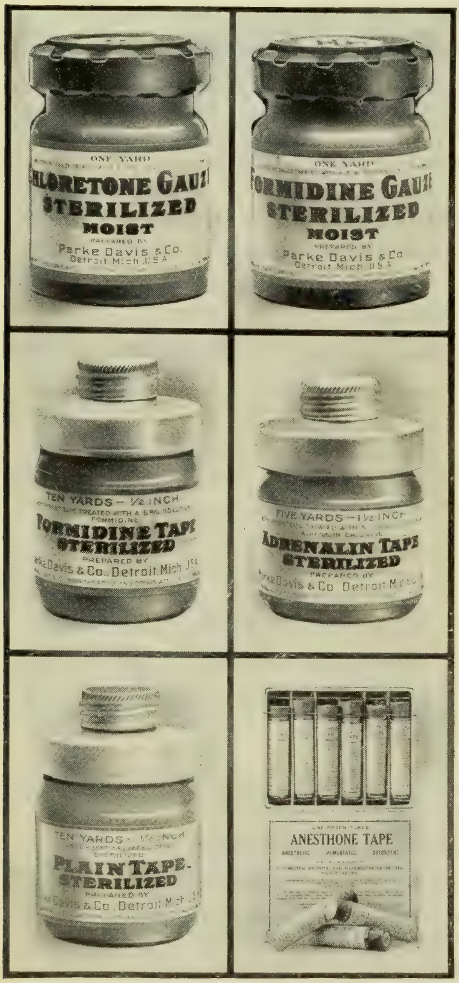

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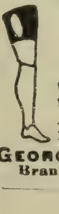

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